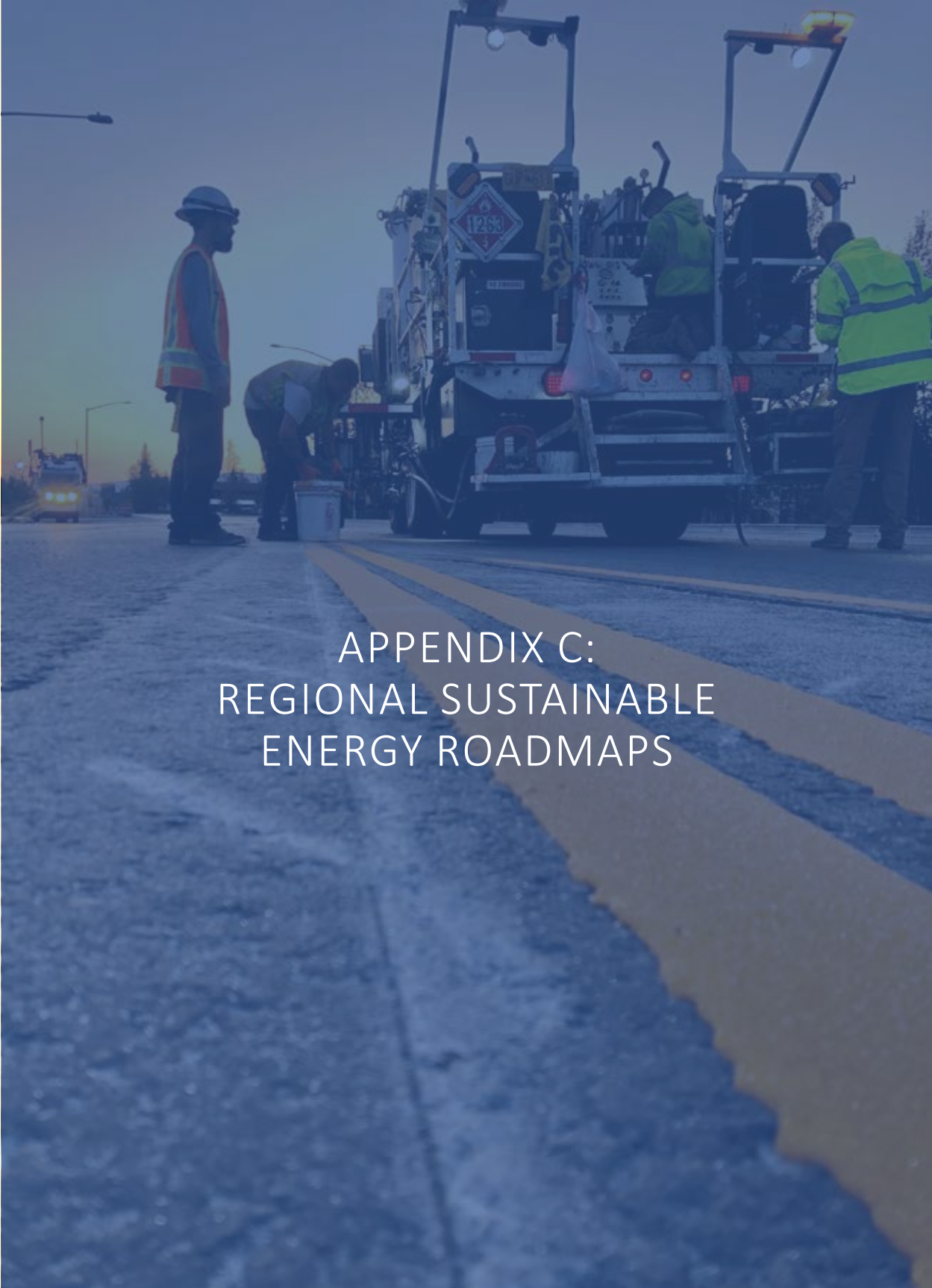


A photograph of construction workers on a road at dusk. In the foreground, a worker in a high-visibility vest and hard hat stands looking towards the right. In the background, another worker is bent over a white bucket, and a third worker is standing near a large piece of construction equipment. The equipment has a diamond-shaped sign with the number '1283' on it. The road is paved with asphalt and has a yellow line painted on it. The sky is a mix of blue and orange from the setting sun. The overall image has a blue tint.

## APPENDIX C: REGIONAL SUSTAINABLE ENERGY ROADMAPS

## TABLE OF CONTENTS

|                                                               |     |
|---------------------------------------------------------------|-----|
| Executive Summary .....                                       | 1   |
| Data Sources.....                                             | 3   |
| Emissions Data .....                                          | 3   |
| Social Determinants of Health Data .....                      | 3   |
| Aleutians East Borough .....                                  | 8   |
| Aleutians West Census Area – Unalaska.....                    | 16  |
| Western Aleutians, Aleutians West Census Area.....            | 28  |
| Lower Kuskokwim, Bethel Census Area.....                      | 37  |
| Bethel, Bethel Census Area .....                              | 46  |
| Upper Kuskokwim, Bethel Census Area.....                      | 54  |
| Bristol Bay Borough .....                                     | 64  |
| Cordova, Chugach Census Area .....                            | 72  |
| Valdez/Western Prince William Sound, Chugach Census Area..... | 81  |
| City and Borough of Juneau .....                              | 89  |
| City and Borough of Wrangell .....                            | 100 |
| Yakutat Borough .....                                         | 108 |
| Copper River Census Area .....                                | 117 |
| Denali Borough.....                                           | 126 |
| Western Bristol Bay, Dillingham Census Area.....              | 135 |
| Dillingham, Dillingham Census Area.....                       | 144 |
| Fairbanks North Star Borough .....                            | 154 |
| Haines Borough .....                                          | 166 |
| Hoonah-Angoon Census Area.....                                | 175 |
| Kenai Peninsula Borough.....                                  | 187 |
| Ketchikan Gateway Borough .....                               | 200 |
| Kodiak Island Borough.....                                    | 210 |
| Kusilvak Census Area .....                                    | 219 |
| Lake and Peninsula Borough .....                              | 227 |
| Matanuska-Susitna Borough .....                               | 235 |
| Municipality of Anchorage .....                               | 246 |
| Municipality of Skagway.....                                  | 258 |
| Bering Straits, Nome Census Area.....                         | 267 |
| City of Nome.....                                             | 276 |
| Prudhoe Bay, North Slope Borough.....                         | 286 |
| Utqiagvik, North Slope Borough.....                           | 296 |
| North Slope Region, North Slope Borough.....                  | 305 |
| Kotzebue, Northwest Arctic Borough .....                      | 317 |
| Northwest Arctic Region, Northwest Arctic Borough .....       | 328 |
| Petersburg Borough.....                                       | 338 |
| Hyder, Prince of Wales-Hyder Census Area .....                | 348 |
| Metlakatla, Prince of Wales-Hyder Census Area .....           | 356 |
| Prince of Wales/Kake, Prince of Wales-Hyder Census Area ..... | 365 |
| Craig/Klawock, Prince of Wales-Hyder Census Area .....        | 372 |
| Downtown Sitka, Sitka Borough .....                           | 379 |
| Outer Sitka, Sitka Borough .....                              | 389 |
| Alaska Highway Region, Southeast Fairbanks Census Area .....  | 400 |
| Delta Region, Southeast Fairbanks Census Area .....           | 410 |
| Iditarod, Yukon-Koyukuk Census Area.....                      | 420 |
| Tanana Flats, Yukon-Koyukuk Census Area.....                  | 429 |
| Upper Yukon, Yukon-Koyukuk Census Area .....                  | 438 |
| Yukon-Koyukuk, Yukon-Koyukuk Census Area .....                | 447 |

## EXECUTIVE SUMMARY

### Purpose and Context

This appendix presents a series of census area–level roadmaps that communities across Alaska can use as guides to inform the development of their own Sustainable Energy Action Plans (SEAPs). Each roadmap represents an integration of multiple data sources—federal social vulnerability indicators, statewide greenhouse gas emissions data, and generative AI–assisted analysis—to identify energy and pollution mitigation opportunities, co-benefits, and strategies tailored to local conditions.

The purpose of these roadmaps is twofold:

1. To translate the findings of the State of Alaska’s Comprehensive Sustainable Energy Action Plan (CSEAP) into community-scale insights that can support local planning, funding applications, and policy development.
2. To provide a consistent and replicable framework that communities can use to evaluate their own risks, identify priorities, and build on existing resilience, hazard mitigation, and infrastructure planning efforts.

Each census area roadmap offers a technical foundation for understanding the interplay between emissions, vulnerability, and capacity—and can serve as a starting point for collaboration among local governments, Tribal entities, utilities, and regional organizations.

### Data Integration and Analytical Approach

The analysis underlying these roadmaps draws on multiple federally available datasets to assess both environmental risk and social vulnerability.

These datasets were combined with the State’s emissions inventory, developed under the CSEAP to form a comprehensive picture of both physical and social risk across Alaska. The resulting dataset provides the quantitative foundation for assessing where mitigation measures will have the greatest cumulative benefit—reducing both criteria pollutants and greenhouse gas emissions, improving affordability, and strengthening community resilience. Communities and regions are likely to have updated or different actual data, which will be important to implement feasible actions. Modeled data is valuable for planning purposes but can’t replace on the ground experience.

See a full list of references in the Data Sources Chapter.

### Use of Generative AI in Analysis

Generative AI was employed to synthesize complex data relationships and generate narrative insights that link technical findings to community-scale implications. Specifically, AI was used to:

- Analyze cross-sectoral data to identify patterns among energy burden, emissions intensity, infrastructure vulnerability, and demographic indicators.
- Generate descriptive narratives that explain how these factors interact within each census area.
- Identify co-benefits associated with mitigation strategies—such as health improvements, economic diversification, or reduced energy insecurity.
- Recommend strategic approaches for investment or policy coordination, aligning local opportunities with state and federal funding mechanisms.

The use of AI does not replace local expertise or community engagement. Rather, it enhances the analytical rigor of the plan by identifying connections and opportunities that can later be validated and refined through local processes. The AI models used for this analysis were trained on national and state-level datasets and calibrated to reflect Alaska’s geographic, economic, and demographic context.

### Structure of the Roadmaps

Each Census Area Roadmap includes the following components:

1. **Baseline Profile:** Overview of energy use, emissions, and key social and economic indicators.
2. **Vulnerability and Risk Assessment:** Summary of physical and social factors contributing to exposure and sensitivity.
3. **Mitigation and Co-Benefit Opportunities:** Identification of strategies that deliver both emissions reductions and community benefits.
4. **Funding and Implementation Considerations:** Reference to applicable federal, state, and private funding programs that could support implementation.
5. **Next Steps for Local Planning:** Suggested pathways for integrating roadmap findings into community resilience, energy, or hazard mitigation plans.

Together, these components establish a consistent and transparent framework for energy transition planning across Alaska’s census areas. They are not prescriptive but adaptable—intended to serve as technical starting points that communities can customize to reflect their priorities, capacities, and values.

### Intended Use and Application

These roadmaps are designed for use by local governments, Tribal councils, regional organizations, and state agencies as they coordinate to achieve the CSEAP’s long-term goals. Each roadmap provides actionable insights that can inform:

- Community or regional Sustainable Energy Action Plans (SEAPs);
- Updates to Hazard Mitigation or Comprehensive Plans;
- Development of energy resilience, broadband, or infrastructure strategies; and
- Targeted applications for federal and state funding opportunities.

By aligning the vulnerability framework with emissions and energy data, the CSEAP ensures that investment decisions advance both equity and efficiency. This integration supports Alaska’s commitment to directing resources toward communities facing the highest energy costs, the most limited access to infrastructure, and the greatest risks.

### Conclusion

The census area–level roadmaps presented in this appendix offer a scalable and data-informed model for local energy and resilience planning. They provide communities with actionable insights derived from the best available data and enhanced through AI-assisted analysis. While these roadmaps establish a strong analytical foundation, they are intended to be iterative and participatory, evolving as communities validate findings, set local priorities, and pursue projects that reflect their unique conditions and aspirations.

In sum, the CSEAP and its community-based roadmap framework represent an important step toward a coordinated, risk-responsive, and sustainable energy future for Alaska—one that connects statewide strategy with community-level action.



## DATA SOURCES

### Emissions Data

This data comes from the State emissions inventory, developed under the CSEAP of the statewide GHG inventory completed for calendar year 2022. The emissions inventory and community reports include:

- Stationary Combustion by fuel type, and percentages by sector.
- Transportation by fuel type, and percentages by road and non-road activity.
- Purchased Electricity by energy type, with percentages contributed.
- Industrial Processes will be addressed during comprehensive planning.
- Methodology, consistent with the approved QAPP.

The methodology used in the inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses from different sources and sectors. The inventory uses [EPA's standard GHG emissions](#) factors and GPC framework to determine metric tons of carbon dioxide equivalent (MTCO<sub>2</sub>e) for three greenhouse gases: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O).

CO<sub>2</sub>e is an abbreviation for carbon dioxide equivalent, the internationally recognized measure of greenhouse gas emissions. Converting emissions of non-CO<sub>2</sub> gases to units of CO<sub>2</sub>e allows greenhouse gases (GHGs) to be compared on a common basis: the ability of each GHG to trap heat in the atmosphere. In this report, non-CO<sub>2</sub> gases have been converted to CO<sub>2</sub>e using internationally recognized Global Warming Potential (GWP) factors from Intergovernmental Panel on Climate Change (IPCC) assessment reports.

### Social Determinants of Health Data

#### Environmental

Anticipated Changes in Extreme Weather: Calculated Future Climate Risk Sub-Component Score.

Annualized Disaster Loss as a National Percentile: Expected Annual Loss (EAL) represents the average economic loss in dollars resulting from natural hazards each year. It is calculated for each hazard type and quantifies loss for relevant consequence types: buildings, people, and agriculture.

Source: FEMA National Risk Index (NRI), <https://hazards.fema.gov/nri/>, 2021

Diesel PM Exposure: Mixture of particles in diesel exhaust in the air, measured as micrograms per cubic meter.

Source: U.S. Environmental Protection Agency, National Air Toxics Assessment (NATA), <https://www.epa.gov/AirToxScreen>, 2022

Air Toxics Cancer Risk: The air toxics cancer risk data is the estimated lifetime inhalation cancer risk from the analyzed carcinogens in ambient outdoor air, as provided by EPA's AirToxScreen. The value of the indicator is persons per million over a 70-year lifetime. The data is reported at the Census block level.

Source: U.S. Environmental Protection Agency, Air Toxics Screening Assessment, <https://www.epa.gov/AirToxScreen>, 2022

Hazardous Sites Proximity (# of tracts): Percent of tract within 1 mile of known hazardous sites.

Source: U.S. Environmental Protection Agency, Federal Registry Service (FRS), <https://www.epa.gov/frs>, 2022

Risk Management Plan RMP Facility Proximity (% of tract): Percent of tract within 1 mile of known Risk Management Plan Sites.

Source: U.S. Environmental Protection Agency, Federal Registry Service (FRS), <https://www.epa.gov/frs>, 2022

## APPENDIX C: REGIONAL SUSTAINABLE ENERGY ROADMAPS

Toxic Releases to Air as a National Percentile: The environmental burden indicator for toxic releases to air measures the average annual chemical concentrations in air weighted by the toxicity of each chemical. This indicator includes chemicals covered by EPA's Toxics Release Inventory (TRI) Program which can cause cancer, other significant human health effects, are reactive, ignitable, or cause significant adverse environmental effects. EJScreen presents these toxic releases using percentile rank, ranging from 0 (lowest) to 100 (highest).

*Source:* U.S. Environmental Protection Agency, Risk-Screening Environmental Indicators (RSEI) Geographic Microdata, <https://www.epa.gov/rsei/rsei-geographic-microdata-rsei-gm>

Hazardous Waste Proximity as a National Percentile: The environmental burden indicator for hazardous waste proximity measures how close people might live to a facility that handles hazardous waste. This indicator calculates the total count of hazardous waste facilities (TSDFs and LQGs) within 5 km (or nearest within 10 km), divided by distance. EJScreen presents hazardous waste proximity using percentile rank, ranging from 0 (lowest) to 100 (highest).

*Source:* U.S. Environmental Protection Agency, Resource Conservation and Recovery Act Information (RCRAInfo) database, <https://enviro.epa.gov/envirofacts/rcrainfo/search>

Superfund Sites Proximity as a National Percentile: The environmental burden indicator for Superfund proximity measures how close people might live to sites listed on the National Priorities List (NPL). This indicator calculates the total count of sites proposed and listed on the NPL within 5 km (or nearest within 10 km), divided by distance. EJScreen presents Superfund proximity using percentile rank, ranging from 0 (lowest) to 100 (highest).

*Source:* U.S. Environmental Protection Agency, Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) <https://cumulis.epa.gov/supercpad/CurSites/srchsites.cfm>

Contains Formerly Used Defense Sites: Properties that were owned, leased, or possessed by the United States, under the jurisdiction of the Secretary of Defense prior to October 1986.

*Source:* U.S. Environmental Protection Agency, Formerly Used Defense Sites (FUDS) <https://www.usace.army.mil/Missions/Environmental/Formerly-Used-Defense-Sites/>

Pre1980s Housing (# of occupied houses): Percent of houses built before 1980.

*Source:* U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, from 2016-2020

High Volume Road Proximity (% of tract): Percent of tract within 1 mile of high volume roads.

*Source:* U.S. Department of Transportation, Bureau of Transportation Statistics (BTS), <https://www.bts.gov/>, 2022

Airport Proximity (% of tract): Percent of tract within 5 miles of airports.

*Source:* U.S. Department of Transportation, Bureau of Transportation Statistics (BTS), <https://www.bts.gov/>, 2022

Properties with Flood Risk as a % of local properties: A high precision, climate-adjusted model that projects flood risk for properties in the future. The dataset calculates how many properties are at risk of floods occurring in the next thirty years from tides, rain, riverine and storm surges, or a 26% risk total over the 30-year time horizon. The risk is defined as an annualized 1% chance. The tool calculates tract-level risk as the share of properties meeting the risk threshold. The risk does not consider property value.

*Source:* First Street Foundation, <https://firststreet.org/>, 2022

## APPENDIX C: REGIONAL SUSTAINABLE ENERGY ROADMAPS

### Health

Asthma Prevalence (% of population): Asthma prevalence among adults aged 18 or older.

Source: U.S Center for Disease Control, PLACES Data, <https://www.cdc.gov/places/index.html>, 2020

Cancer Prevalence (% of population): Cancer (excluding skin cancer) prevalence among adults aged 18 or older.

Source: U.S Center for Disease Control, PLACES Data, <https://www.cdc.gov/places/index.html>, 2020

High Blood Pressure (% of population): High blood pressure prevalence among adults aged 18 or older.

Source: U.S Center for Disease Control, PLACES Data, <https://www.cdc.gov/places/index.html>, 2020

Diabetes Prevalence (% of population): Share of people ages 18 years and older who have been told by a health professional that they have diabetes other than diabetes during pregnancy.

Source: U.S Center for Disease Control, PLACES Data, <https://www.cdc.gov/places/index.html>, 2020

Poor Mental Health Prevalence (% of population): Poor mental health prevalence among adults aged 18 or older.

Source: U.S Center for Disease Control, PLACES Data, <https://www.cdc.gov/places/index.html>, 2020

Heart Disease Prevalence as a National Percentile: Share of people ages 18 years and older who have been told by a health professional that they had angina or coronary heart disease.

Source: U.S Center for Disease Control, PLACES Data, <https://www.cdc.gov/places/index.html>, 2020

Average Life Expectancy: Average life expectancy data developed as a collaboration between NCHS, the National Association for Public Health Statistics and Information Systems, and the Robert Wood Johnson Foundation.

Source: U.S. Center for Disease Control, U.S. Small-Area Life Expectancy Estimates Project (USALEEP) <https://www.cdc.gov/nchs/nvss/usaleep/usaleep.html#data>, 2010-2015

Low Life Expectancy as a National Percentile: The tool reverses the percentiles for this burden. This means that census tracts with lower numbers have higher life expectancies and that census tracts with higher numbers have lower life expectancies.

Source: U.S. Center for Disease Control, U.S. Small-Area Life Expectancy Estimates Project (USALEEP) <https://www.cdc.gov/nchs/nvss/usaleep/usaleep.html#data>, 2010-2015

### Socioeconomic

<200% Federal Poverty Line (% of population): Percent of a census tract's population in households where household income is at or below 200% of the Federal poverty level, not including students enrolled in higher education.

Source: U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, 2016-2020

No HS Diploma (% of population): Share of people aged 25 years or older who didn't graduate from high school.

Source: U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, 2016-2020

Unemployment (% of population): Number of unemployed people as a share of the labor force.

Source: U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, 2016-2020

Renter Occupied Units (% of housing units): Percent of total housing units that are renter-occupied.

Source: U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, 2016-2020

## APPENDIX C: REGIONAL SUSTAINABLE ENERGY ROADMAPS

Housing Cost Burden (% of population): Share of households that are both earning less than 80% of Housing and Urban Development's Area Median Family Income and are spending more than 30% of their income on housing costs.

Source: U.S. Department of Housing and Urban Development, Comprehensive Housing Affordability Strategy (CHAS) Dataset, <https://www.huduser.gov/portal/datasets/cp.html>, 2014-2018

Median Home Value: Median value (\$) of owner-occupied housing units.

Source: U.S. Department of Housing and Urban Development, Comprehensive Housing Affordability Strategy (CHAS) Dataset, <https://www.huduser.gov/portal/datasets/cp.html>, 2014-2018

Uninsured as a % of population: Percent of all persons without Health Insurance Coverage.

Source: U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, 2016-2020

Lack of Internet Access as a % of population: Percent of households with no internet subscription.

Source: U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, 2016-2020

Energy Burden (annual cost avg): Average household annual energy cost in dollars divided by the average household income.

Source: U.S. Department of Energy, Low-income Energy Affordability Data (LEAD) Tool, <https://www.energy.gov/scep/slsc/lead-tool>, 2018

GINI Income Inequality Index: The Gini Index is a summary measure of income inequality. The Gini coefficient incorporates the detailed shares data into a single statistic, which summarizes the dispersion of income across the entire income distribution. The Gini coefficient ranges from 0, indicating perfect equality (where everyone receives an equal share), to 1, perfect inequality (where only one recipient or group of recipients receives all the income). The Gini is based on the difference between the Lorenz curve (the observed cumulative income distribution) and the notion of a perfectly equal income distribution.

Source: U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, 2016-2020

% of Population 65 or older: Percent of population 65 years or older.

Source: U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, 2016-2020

% of Population 17 or younger: Percent of population 17 years or younger.

Source: U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, 2016-2020

Disability as a % of population: Percent of all persons with disabilities. Considers six disability types: hearing difficulty, vision difficulty, cognitive difficulty, ambulatory difficulty, self-care difficulty, and independent living difficulty. Respondents who report any one of the six disability types are considered to have a disability.

Source: U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, from 2015-2019

Limited English Proficiency as a % of population: Share of households where no one over age 14 speaks English very well.

Source: U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, from 2015-2019

Mobile Homes as a % of housing units: Percent of total housing units that are mobile homes

Source: U.S. Census Bureau, American Community Survey (ACS), <https://www.census.gov/programs-surveys/acs>, from 2015-2019

Pre1960s Housing as a % of Occupied Houses: Percent pre-1960s housing (lead paint indicator)

### Transportation Insecurity

Transportation Access Score: The Average of Transportation Indicator uses an average of four transportation-related indicator percentiles, including Transportation Cost Burden, National Walkability Index, Percentage of Households with No Vehicle Available, and Mean Commute Time to Work.

Source: U.S. Department of Transportation, Transportation Disadvantaged Census Tracts, <https://www.transportation.gov/priorities/equity/justice40/transportation-insecurity-analysis-tool>

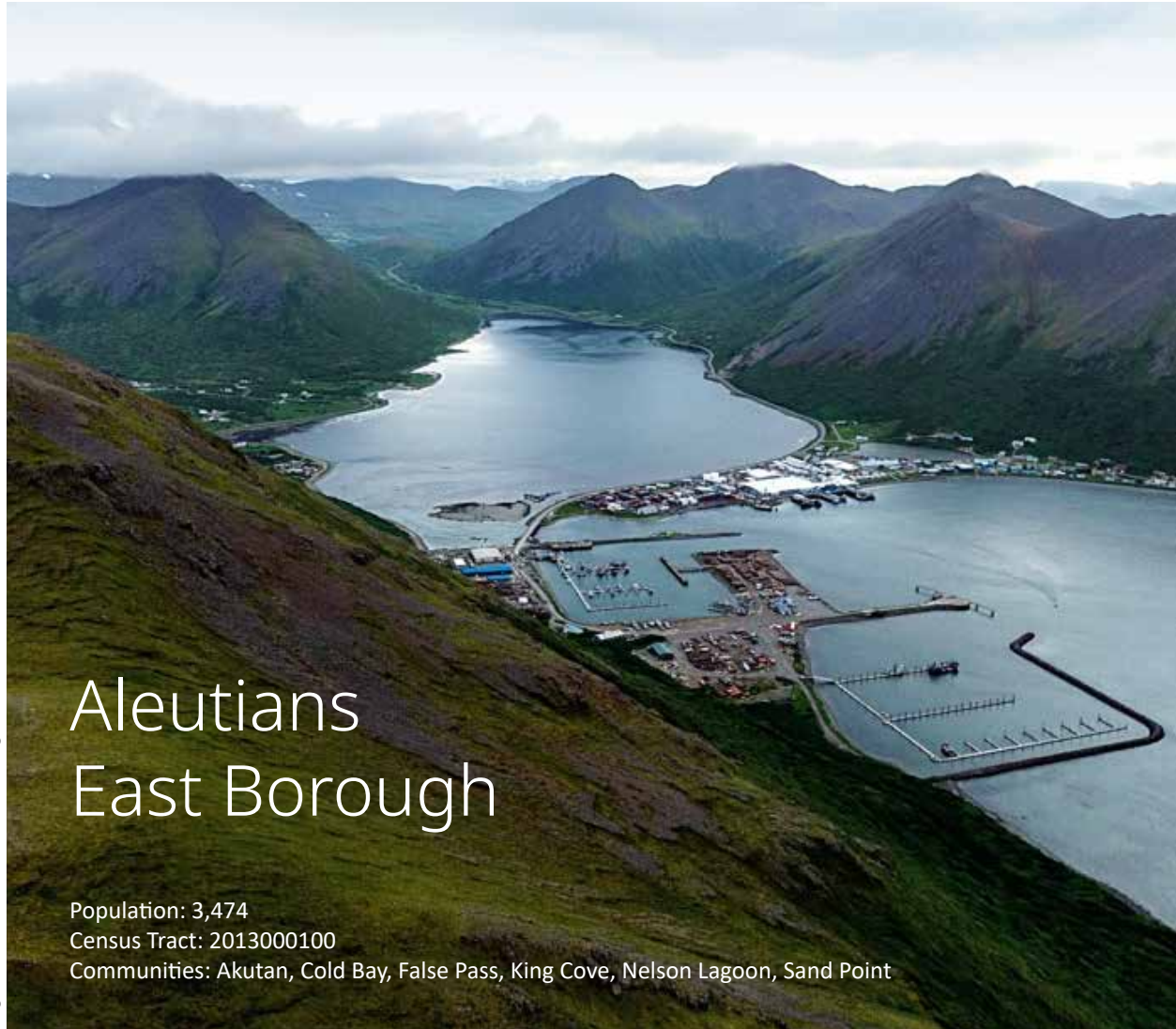
Transportation Cost Burden as a % of household: Calculated average annual cost of Transportation as percent of household income.

Traffic Safety Fatalities per 100,000 population: Traffic Fatalities per 100,000 people

Source: U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA), <https://www.nhtsa.gov/>, 2017-2021







# Aleutians East Borough

Population: 3,474

Census Tract: 2013000100

Communities: Akutan, Cold Bay, False Pass, King Cove, Nelson Lagoon, Sand Point

The Aleutians East Borough is a remote, coastal region shaped by its geography, economy, and people. Communities here face distinct challenges—high energy costs, health disparities, and infrastructure limitations—alongside opportunities to strengthen local systems and improve quality of life. This roadmap offers a clear picture of current conditions, from health and socioeconomic indicators to patterns of energy use and transportation, and outlines practical strategies to reduce household costs, improve public health, and build more reliable local services. By centering residents with the greatest needs, the Borough can ensure future initiatives deliver the most meaningful benefits, bolstering community resilience and long-term prosperity.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Home weatherization + electrification
2. Community-scale renewable generation with storage
3. Fleet electrification paired with renewable diesel in freight/marine sectors

These not only address the Borough's largest emissions sources but also directly relieve financial and health burdens for the most vulnerable residents.

## Emissions Data Overview

Total Modeled Emissions: 25,343 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (66.15%)

- Residential Sector (48.30%)
  - Dominated by Residual Fuel Oil No. 5, accounting for 11,813 mt CO<sub>2</sub>e (46.6% of total emissions).
  - Electricity: 399 mt CO<sub>2</sub>e (1.6%).
  - Natural Gas: 23 mt CO<sub>2</sub>e (0.1%).
  - Wood/Wood Residuals: negligible at 5 mt CO<sub>2</sub>e (0.02%).
- Commercial Sector (17.85%)
  - Distillate Fuel Oil No. 1: 3,200 mt CO<sub>2</sub>e (12.6%).
  - Propane: 244 mt CO<sub>2</sub>e (1.0%).
  - Electricity: 1,071 mt CO<sub>2</sub>e (4.2%).
  - Wood/Wood Residuals: again negligible.
- Industrial Sector: 0%. No direct emissions from industrial combustion processes were reported.

### Transportation (33.85%)

- Motor Gasoline (main contributor): 7,228 mt CO<sub>2</sub>e (28.5%).
- Diesel Fuel: 1,351 mt CO<sub>2</sub>e (5.3%).
- Electricity (vehicles): trivial at 0.1 mt CO<sub>2</sub>e.

In terms of vehicle types:

- Trucks account for the overwhelming majority—8,094 mt CO<sub>2</sub>e (94.3% of the transportation sector).
- Passenger vehicles: 474 mt CO<sub>2</sub>e (5.5%).
- Motorcycles: minimal at 11 mt CO<sub>2</sub>e (0.1%).

### Electricity Generation

- Total electricity consumption: 6,545 MWh.
  - Petroleum-fueled generation: 1,470 mt CO<sub>2</sub>e, comprising 100% of GHGs in this category.
  - Wind (196 MWh) and Hydro (1,244 MWh): zero direct CO<sub>2</sub>e emissions.

This indicates reliance on petroleum-based generation for in community electricity.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Solid waste and wastewater emissions were not included in this dataset.

### Key Takeaways

- Two dominant sources: stationary combustion (roughly two-thirds of total emissions) and transportation (about one-third).
  - Residential and commercial use of heavy fuel oils (especially Residual Fuel Oil No. 5 and Distillate Fuel Oil No. 1) are the largest contributors.
  - Truck transportation, powered primarily by motor gasoline and diesel, is the major transport-related GHG source.
- Electricity emissions, while smaller in share, are tied fully to petroleum-based generation, demonstrating a reliance on fossil-fueled power for local energy needs.

## Social Determinants of Health

### Environmental Conditions

- **High Risk from Extreme Weather** – An anticipated change in extreme weather index of 85.8 indicates the area is highly vulnerable to environment-related hazards such as storms, heavy precipitation, and other extreme events. This aligns with the coastal geography and reliance on maritime industry.
- **Disaster Loss** – The annualized disaster loss percentile (31.25) is moderate nationally, but the dollar figure (~\$561K) is significant for a small, remote region with limited infrastructure redundancy.
- **Air Quality & Pollution Sources** – Diesel particulate matter (PM) exposure is relatively low in absolute terms, but the proximity to Risk Management Plan (RMP) facilities (74th percentile nationally) suggests the potential for acute chemical release risks. Toxic air releases rank in the low percentile (9), but the presence of formerly used defense sites may signal legacy contamination concerns.
- **Flood Risk** – Reported at zero, which may reflect coastal topography rather than absence of hazard—storm surge and sea level rise may still pose risks.

Implication: The environmental profile suggests a population already exposed to environmental hazards, with high vulnerability to future extreme weather events. Any emissions reduction strategies will need to integrate resilience measures and address industrial and transportation emissions sources.

### Public Health Indicators

- **Chronic Disease Prevalence** – Diabetes (11.1%, 99th percentile nationally) and high blood pressure (32.3%, 95th percentile) are extremely high. Asthma and cancer prevalence are above average.
- **Mental Health** – Poor mental health prevalence (11.5%, 74th percentile) is higher than the national median, possibly tied to social isolation, economic stressors, and environmental stress.
- **Life Expectancy** – Average life expectancy (86.9 years) is well above national averages, but the low life expectancy percentile (1st) suggests a stark disparity between different subpopulations.

Implication: Chronic disease burdens may heighten sensitivity to pollution and environmental stressors, especially for older adults and those with respiratory conditions. Public health co-benefits should be emphasized in future planning.

### Socioeconomic Factors

- **Poverty & Education** – Nearly 30% of residents live under 200% of the federal poverty line, and the proportion without a high school diploma (13.4%, 90th percentile) is very high. This indicates limited access to economic mobility and skilled labor.
- **Housing & Costs** – A relatively high renter population (38.6%) suggests less housing stability. However, housing cost burden is low (14.3%, 8th percentile), reflecting lower home values (\$119,900 median).
- **Access Gaps** – Extremely high uninsured rates (39.7%, 99th percentile) and lack of internet access (42.1%, 97th percentile) present serious barriers to healthcare, information, and participation in sustainability program.
- **Demographics** – The population skews older (11.2%, 99th percentile for seniors) with a relatively low proportion of youth. Limited English proficiency is very high (10.2%, 99th percentile), suggesting linguistic diversity and the need for multilingual outreach.

Implication: These socioeconomic challenges will influence the feasibility and uptake of emissions reduction-related initiatives. Energy burden (4%, 83rd percentile) indicates that household energy costs are already a notable strain, meaning efficiency measures and cleaner energy sources could have strong benefit for economically disadvantaged communities.

## Intersection with Emissions Reduction Planning

The conditions above shape the context for future decisions:

- **Health Vulnerabilities** – Chronic disease prevalence means the population may experience disproportionate health improvements from reductions in air pollution and diesel emissions.
- **Economic & Access Barriers** – High poverty, limited internet, and language diversity require emissions reduction initiatives to be tailored for accessibility, affordability, and cultural relevance.
- **Infrastructure & Environmental Risk** – The combination of high extreme weather vulnerability and reliance on maritime transport will necessitate integrated resilience measures alongside emissions reduction.
- **Community Readiness** – Education levels, health coverage gaps, and communication challenges may slow adoption unless paired with robust public engagement and support systems.

## Mitigation Strategies

### Residential and Community Energy Transition

In Aleutians East Borough, the single largest source of greenhouse gas emissions comes from heating homes with Residual Fuel Oil No. 5. This dependency drives both high emissions and a notable energy burden, meaning households are spending a larger share of their income on energy compared to most other communities. Reducing this dependency offers a dual benefit — substantial emissions reductions and immediate cost relief for households.

A strong first step would be to invest in deep weatherization programs that focus on insulating homes, sealing drafts, and upgrading windows. Prioritizing vulnerable households ensures that those most affected by high energy costs and poor housing quality see the earliest benefits. Coupled with this, electrification through heat pumps for space and water heating can replace heavy fuel oil entirely, especially if paired with on-bill financing or grant programs to remove upfront cost barriers. In parallel, community solar and battery storage systems can be developed so that even renters or households with unsuitable roofs can participate in clean energy generation and enjoy lower, more predictable energy costs. Smart thermostats and energy management tools can further reduce demand, helping to manage limited grid capacity and cut costs over time.

### Transportation Emissions Reduction

The second largest contributor to local emissions comes from transportation, where trucks running on gasoline and diesel dominate. In a region where goods and people move over long distances and in challenging weather conditions, any solution must be both reliable and cost-effective.

A targeted approach could begin with electrifying municipal fleets, including school buses, emergency vehicles, and service trucks, to demonstrate feasibility and reliability in local conditions. Incentives could encourage local businesses to adopt renewable diesel or biofuels for heavy-duty and marine transport, serving as a bridge where full electrification is not yet practical. The installation of EV charging stations at key hubs — ports, ferry terminals, and central community spaces — would create the infrastructure backbone needed for broader adoption. While the region's dispersed communities make large-scale active transportation infrastructure challenging, creating safe pedestrian and cycling routes within village centers could reduce short-distance vehicle trips, improving both air quality and community health.

### Local Renewable Generation and Storage

Although electricity accounts for a smaller portion of total emissions, nearly all local generation comes from petroleum. This means that decarbonizing electricity production is essential to maximizing the benefits of residential and transportation electrification.

Building on existing wind capacity, the Borough could deploy hybrid renewable energy systems combining wind, solar, and battery storage. These systems can significantly reduce reliance on imported



diesel, while also improving grid stability and resilience during extreme weather events — a key consideration for coastal communities. Opportunities for small-scale hydropower or tidal energy pilots could also be explored, given the region’s geography. Battery storage, whether at the household or community scale, would enable renewables to serve more of the daily energy load and allow stored energy to be used during high-demand or emergency periods.

### **Waste and Resource Management**

While current emissions inventories for Aleutians East Borough do not report significant waste-related emissions, methane from landfill decomposition can be a significant source of emissions in small, isolated communities, and waste disposal costs are high. Addressing this sector offers both environmental and economic benefits.

The Borough could invest in community composting programs that divert organic waste from landfills and produce compost for local landscaping or gardening projects. In a fishing-dependent region, anaerobic digestion of fish processing waste and other organics could produce local biogas, which could supplement heating needs or even generate electricity. Expanding recycling and material recovery for high-value commodities like metals and cardboard would further reduce waste volumes and shipping costs.

### **Improved Outcomes for Overburdened and Underserved Communities**

Across all these strategies, a deliberate focus on energy-burdened communities will ensure that the benefits of emissions reduction actions — lower energy bills, cleaner air, more reliable power, and reduced vulnerability to fuel price spikes — are felt first and most by those who need them most. By prioritizing households facing the highest energy burdens, limited access to healthcare, and language barriers, the Borough can design programs that not only cut emissions but also improve overall well-being. This includes delivering outreach in multiple languages, using trusted community organizations to engage residents, and creating local job opportunities through green workforce training programs.

In short, the most effective path for Aleutians East Borough is to replace heavy fuel oil in homes with efficiency and electrification, decarbonize local transport fleets and freight, expand renewable generation with storage, and reduce waste through composting and biogas production. Done with a focus on underserved and overburdened communities, these measures will cut emissions while strengthening resilience, lowering costs, and improving health outcomes.



Sand Point: © www.aleutianseast.org



## Benefit (Disbenefit) Quantification or Qualitative Analysis

### Residential and Community Energy Transition

Key Actions: Weatherization, heat pumps, community solar, energy management systems.

| Potential Impact    | Quantitative/Qualitative Assessment                                                                                                                             | Community Benefits                                                                                           |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| GHG Reduction       | High – Could address ~46–50% of total emissions (largest single sector: Residual Fuel Oil No. 5 in homes).                                                      | Vulnerable households often live in older, leakier homes, so per-home emission savings may be above average. |
| Energy Cost Savings | High – Switching from heavy fuel oil (~\$7–\$9/gal delivered in rural AK) to efficient electric heat pumps can cut annual heating bills by 30–60%.              | Reduces energy burden (83rd percentile) significantly, freeing income for essentials.                        |
| Health Benefits     | High – Lower indoor PM2.5 from oil combustion improves respiratory outcomes, important in a population with high asthma, diabetes, and hypertension prevalence. | Directly benefits households with existing chronic disease and poor indoor air quality.                      |
| Resilience          | Moderate – If paired with storage, solar and heat pumps reduce dependence on imported fuels vulnerable to weather disruptions.                                  | Underserved areas often experience longer service delays after storms; local generation increases autonomy.  |
| Disbenefits / Risks | Upfront capital costs, even with subsidies; workforce gaps for installation; possible resistance if systems underperform in extreme cold without proper design. | Vulnerable households risk being excluded without fully subsidized programs and targeted outreach.           |



Cold Bay: © www.alutianseast.org

### Transportation Emissions Reduction

Key Actions: Fleet electrification, renewable diesel, EV charging hubs, active transport in village centers.

| Potential Impact    | Quantitative/Qualitative Assessment                                                                                                              | Community Benefits                                                                                                                                               |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG Reduction       | Moderate–High – Addresses ~33% of emissions; heavy-duty trucks dominate, so electrification + renewable diesel can yield 15–25% total reduction. | Public fleet electrification benefits all via reduced emissions in populated areas; renewable diesel reduces exposure in fishing ports and along freight routes. |
| Energy Cost Savings | Moderate – EVs have lower operating costs per mile; renewable diesel may be more expensive than petroleum in short term.                         | Low-income households benefit if EV adoption includes subsidies and shared mobility programs to reduce personal transport costs.                                 |
| Health Benefits     | Moderate–High – Reduces diesel PM exposure, particularly in port towns and near schools.                                                         | Strong impact for communities with high respiratory disease burden.                                                                                              |
| Resilience          | Moderate – Diversifies away from imported petroleum; requires reliable local charging powered by renewables to maintain benefits.                | Charging hubs in underserved areas reduce geographic inequities in access.                                                                                       |
| Disbenefits / Risks | High upfront cost of EVs and chargers; charging downtime risk if grid is weak; renewable diesel supply chain uncertainties.                      | Without policy safeguards, charging stations may cluster in higher-income areas, leaving some communities behind.                                                |

### Local Renewable Generation & Storage

Key Actions: Hybrid wind-solar-battery systems, tidal/hydro pilots.

| Potential Impact    | Quantitative/Qualitative Assessment                                                                                                                    | Community Benefits                                                                                                                 |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| GHG Reduction       | Moderate – Petroleum-based generation accounts for ~5% of total emissions, but decarbonizing it amplifies benefits of electrifying heat and transport. | Vulnerable communities benefit disproportionately when paired with electrification programs (avoids high diesel generation costs). |
| Energy Cost Savings | Moderate–High – Reduces volatility of fuel costs; past rural AK wind-diesel hybrids have cut fuel use by 20–50%.                                       | Lower, stable power rates help reduce household financial stress in high-poverty areas.                                            |
| Health Benefits     | Moderate – Less diesel generation reduces community-level PM and NOx emissions.                                                                        | Improves air quality in communities close to generation sites.                                                                     |
| Resilience          | High – Local renewable + storage improves energy security during fuel shipment delays or storm disruptions.                                            | Underserved areas are often last in line for fuel resupply; local generation is a buffer.                                          |
| Disbenefits / Risks | High capital costs; maintenance requirements; renewable intermittency without sufficient storage.                                                      | Without dedicated investment, smallest/poorest communities risk being last to benefit.                                             |

## Waste and Resource Management

Key Actions: Composting, anaerobic digestion, recycling.

| Potential Impact    | Quantitative/Qualitative Assessment                                                                                                  | Community Benefits                                                                                           |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| GHG Reduction       | Low–Moderate – Not a major reported source, but methane reductions possible from diverting organics.                                 | Underserved communities often lack waste diversion programs; benefits accrue from reduced landfill reliance. |
| Energy Cost Savings | Low–Moderate – Anaerobic digestion can offset heating/electricity costs locally; composting reduces landfill tipping/shipping costs. | Reduces municipal waste fees that disproportionately burden low-income households.                           |
| Health Benefits     | Low–Moderate – Reduces odors, pests, and potential water contamination from landfills.                                               | Improves environmental health in areas closest to waste sites.                                               |
| Resilience          | Moderate – Local waste-to-energy projects can supply emergency fuel; compost supports local food systems.                            | Supports food security in communities via community gardens.                                                 |
| Disbenefits / Risks | Requires consistent feedstock; operational expertise for digesters; upfront costs may outweigh savings if small-scale.               | Communities may struggle to fund or operate without ongoing support.                                         |

## Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy costs → reduces high energy burden percentile.
- Improved indoor and outdoor air quality → mitigates asthma, heart disease, and chronic conditions.
- More stable and resilient local energy supply → reduces vulnerability during extreme weather or supply chain disruptions.
- Local job creation in clean energy and efficiency → builds skills and income in-region.
- Multilingual, culturally appropriate outreach → ensures participation by Limited English Proficiency (LEP) households.

Potential disbenefits if not designed equitably:

- Upfront costs or credit requirements could exclude low-income households.
- Infrastructure (EV, renewables) could concentrate in higher-income or more accessible areas.
- Workforce training could bypass smaller or more remote communities without targeted inclusion.

## Path Forward

Aleutians East Borough's greatest challenges—high energy costs, reliance on fossil fuels, and health disparities—are also its strongest opportunities for change. The roadmap identifies clear priorities: replacing heavy fuel oil in homes, modernizing transportation, expanding renewable generation with storage, and improving waste management.

By focusing on vulnerable communities, these strategies can cut emissions while reducing household costs, improving health, and strengthening resilience. By focusing on emissions reduction and resilience, the Borough can turn current vulnerabilities into long-term community benefits.

The Aleutians East Borough cannot achieve these goals alone. Success will depend on the collective efforts of local governments, tribal organizations, utilities, schools, businesses, and residents working together. By building strong partnerships, the Aleutians East Borough can secure funding, share knowledge, and ensure that programs are tailored to the unique needs of our communities.

# Aleutians West Census Area – Unalaska

Population: 4,120  
Census Tract: 2016000200



Unalaska, the largest community in the Aleutians West Census Area, faces a dual challenge: reducing its heavy reliance on petroleum fuels while addressing the interconnected social and health factors that shape community well-being. With total modeled emissions of 67,328 metric tons of CO<sub>2</sub>e, the region's energy profile is dominated by stationary combustion from fuel oils (87.6%), petroleum-based electricity generation (15%), and truck-heavy transportation (12.4%). These sources overlap with conditions that heighten community vulnerability—high chronic disease rates, a large uninsured population (14.8%), and aging, predominantly rental housing (77.9%). Together, these factors underscore the importance of strategies that lower emissions while also improving health, affordability, and resilience for residents most affected by energy and environmental burdens.

At the same time, opportunities exist for transformational improvements across Unalaska's energy, housing, and transportation systems. The community's petroleum dependence presents not only a major source of emissions but also an avenue for innovation—where local action can yield meaningful economic, health, and resilience benefits. Reducing fuel oil consumption, improving building performance, and diversifying the energy supply would directly lower household energy costs, improve indoor air quality, and reduce vulnerability to extreme weather and market volatility. When approached through a community-centered lens, these changes can advance both emissions reduction and social goals, ensuring that investments in efficiency, renewable power, and infrastructure resilience deliver equitable benefits to all residents, particularly those facing the highest cost burdens and health risks.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and Community co-benefits:

1. Comprehensive Building Weatherization & Efficiency Retrofits
2. Petroleum-to-Renewables Transition in Community Power
3. Transportation & Harbor Electrification with Fleet Efficiency

Together, these three strategies deliver the largest emissions reductions by tackling petroleum dependence in electricity, buildings, and transportation—the region’s biggest drivers of GHGs. At the same time, they generate cross-cutting benefits: lower utility costs, improved health outcomes, stronger housing quality, and greater disaster resilience. By sequencing weatherization first, followed by renewable integration and transport electrification, Aleutians West can achieve emissions reduction goals while ensuring the most vulnerable populations experience tangible, near-term improvements in daily life.

## Emissions Data Overview

Total Modeled Emissions: 67,328 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (87.64%)

- Residential (22.2% of total)
  - Residual Fuel Oil No. 5: 13,691 mt CO<sub>2</sub>e (dominant source, 20.34% of community total).
  - Electricity: 1,120.95 mt CO<sub>2</sub>e (1.66%).
  - Propane: 101 mt CO<sub>2</sub>e (0.15%).
  - Wood & Wood Residuals: 1 mt CO<sub>2</sub>e (negligible).
- Commercial Sector (19.19%)
  - Electricity: 10,816.10 mt CO<sub>2</sub>e (16.06%)
  - Distillate Fuel Oil No. 1: 3,882.53 mt CO<sub>2</sub>e (5.77%)
  - Propane: 296.39 mt CO<sub>2</sub>e (0.44%)
  - Wood & Wood Residuals: 10.78 mt CO<sub>2</sub>e (0.02%)
- Industrial Sector: 36.6%.
  - 29,084.86 mt CO<sub>2</sub>e (43.2%)

### Transportation (12.36%)

- Motor Gasoline (main contributor 6,670.83 mt CO<sub>2</sub>e (2.45%))
- Diesel Fuel: 1,651.69mt CO<sub>2</sub>e (2.45%)
- Electricity (vehicles): 0.10 mt CO<sub>2</sub>e (negligible)

In terms of vehicle types:

- Trucks: 7,945.87 mt CO<sub>2</sub>e (95.47%)
- Passenger vehicles: 366.88 mt CO<sub>2</sub>e (4.41%)
- Motorcycles: 10.17 mt CO<sub>2</sub>e (0.12%)

### Electricity Generation

- Total electricity consumption: 41,448.43 MWh
  - Petroleum-fueled generation: 41,448.43 MWh → 11,937.15 mt CO<sub>2</sub>e (100%)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use):

- Solid waste and wastewater emissions were not included in this dataset.

### Key Takeaways

Unalaska’s total modeled emissions are 67,328 metric tons of CO<sub>2</sub>e, with the majority stemming from stationary combustion, particularly in the industrial (36.6%), residential (22.2%), and commercial (19.2%) sectors. Residual Fuel Oil No. 5 in homes is a dominant source, while commercial emissions are driven largely by electricity use and distillate fuel oil. Transportation contributes 12.4%, overwhelmingly from



trucks, while electricity generation adds another 15%, all from petroleum-fueled sources. This profile highlights Unalaska's heavy reliance on petroleum products across sectors, underscoring significant opportunities for efficiency improvements and cleaner energy transitions.

## Social Determinants of Health

### Environmental Conditions

- High exposure to extreme weather risk (78.98) and disaster loss percentile (77.84%)  
*Indicates that Unalaska is highly vulnerable to severe weather and natural hazards, with disaster-related costs exceeding \$2.2 million annually.*
- Flood risk for 13% of properties (74th percentile nationally)  
*Flooding is a significant local hazard, placing homes, businesses, and infrastructure at risk.*
- Proximity to formerly used defense sites  
*While no active Superfund or hazardous waste sites are recorded, legacy defense sites can pose lingering contamination risks.*
- Air quality risks relatively low (Diesel PM exposure 0.16; air toxics cancer risk 8; toxic releases negligible)  
*Industrial pollution burden is limited compared to other areas, though reliance on diesel fuel suggests potential exposure concerns.*
- Limited built environment risks (airport proximity moderate at 2.49%; high-volume road proximity = 0)  
*Suggests reduced direct exposure to traffic-related pollution, but also possible transportation isolation.*

Implications: Environmental vulnerabilities—particularly extreme weather, flood risk, and legacy defense sites—create heightened sensitivity to infrastructure resilience and energy choices. These risks will shape how emissions reduction strategies are received, especially where they align with disaster preparedness.

### Public Health Indicators

- Chronic conditions elevated:
  - High blood pressure prevalence: 28.1% (80th percentile nationally).
  - Diabetes prevalence: 8.5% (90th percentile nationally).
  - Asthma: 7.1% (65th percentile).
  - Cancer prevalence: 3.3% (60th percentile).
- Mental health concerns significant with 10.4% reporting poor mental health (69th percentile).
- Life expectancy strong at 79.5 years, though still below healthier regions; low life expectancy percentile = 39.
- Heart disease low (8th percentile) compared to national averages.

Implications: The prevalence of chronic disease (especially diabetes and hypertension) signals vulnerabilities that may be worsened by environmental stressors and energy insecurity. Emissions reduction planning will need to account for health equity, ensuring solutions reduce local pollution and support long-term health improvements.

### Socioeconomic Factors

- Housing pressures:
  - Renter occupancy is extremely high at 77.9% (95th percentile nationally).
  - Median home value: \$368,000 (78th percentile).
  - Pre-1960 housing stock: 17% → potential for older, less energy-efficient housing.
- Education and language barriers:
  - 8.4% of population lacks a high school diploma (70th percentile).
  - 9.4% have limited English proficiency (98th percentile nationally).
- Poverty relatively modest at 18% (34th percentile), but 14.8% uninsured (61st percentile).

- Energy burden moderate at 3% (52nd percentile), but costs remain a concern given reliance on petroleum fuels.
- Demographics:
  - Older adults: 6.6% of population (90th percentile).
  - Youth (under 17): 17.3% (15th percentile).
  - Disability rate low at 6.7% (11th percentile).

**Implications:** High rental housing, older housing stock, and significant language barriers suggest challenges for implementing household-level efficiency upgrades or clean energy transitions. Community engagement will need to be culturally and linguistically accessible. Financial and housing constraints may limit ability to adopt new technologies without strong support.

### Intersection with Emissions Reduction Planning

- Energy and housing context: The reliance on older housing and petroleum fuels increases both costs and pollution. Strategies must balance affordability, housing quality, and emissions reduction.
- Community vulnerability: Elevated disaster and flood risk heightens the importance of resilience-focused planning. Emissions reduction strategies that double as disaster preparedness will be most relevant.
- Health equity: Chronic conditions like diabetes and hypertension amplify the importance of reducing air pollution and improving indoor environments. Public health benefits should be clearly communicated.
- Socioeconomic access: High renter rates and language diversity highlight the need for inclusive, community-driven approaches. Without equitable design, benefits may bypass the most vulnerable.

**Implications:** Emissions pollution reduction planning in Aleutians West must be integrated with social and health equity concerns, ensuring strategies are accessible, affordable, and supportive of resilience. Recognizing these intersecting vulnerabilities will help the region align environmental goals with community needs.

## Mitigation Strategies

### Energy transition & community power systems

Unalaska's profile shows heavy reliance on petroleum for electricity (100% of 41,448 MWh; ~11,937 mt CO<sub>2</sub>e) and very high stationary combustion overall (87.6%), with industrial (36.6%) the largest slice of community emissions. That makes supply-side decarbonization and diesel reduction foundational. State pathways in the Priority Plan explicitly contemplate community generation & transmission projects, renewable integration, and diesel efficiency programs (DERA / VEEP / rural distribution), plus REF and Solar for All—each designed to lower generation costs and displace diesel in remote systems.

Paired with local grid optimization and waste-heat capture, these steps reduce fuel imports, smooth price shocks, and strengthen resilience in a place with high disaster and flood risk.

Targeted actions:

- Renewable additions (wind/solar with storage; hydrokinetic where feasible) sized for Unalaska's islanded grid; controls and switchgear upgrades to maximize renewable penetration without compromising reliability.
- Diesel plant optimization & heat recovery (VEEP/DERA-type measures) to cut fuel burn now while new renewables come online.
- Community solar + behind-the-meter efficiency for public/nonprofit facilities via Solar for All + non-residential retrofits to reduce daytime loads and peak.

**Implications:** Lower generation costs and fewer fuel deliveries reduce energy burden (already mid-range at 3%) and improve air quality/indoor comfort—important where hypertension (28.1%) and diabetes (8.5%) are elevated and weather disruptions are common. Benefits reach renters and multi-family residents if public buildings and shared services see early savings.

**Buildings: weatherization first, then fuel switching where it pencils**

Given Unalaska's older housing stock (17% pre-1960), very high renter share (77.9%), and the residential role of Residual Fuel Oil No. 5 (20.3% of community total), the most certain near-term cuts come from deep envelope upgrades and high-efficiency heating in both housing and public facilities. The Priority Plan backs AHFC Weatherization & Rebate programs and a broad public-facility retrofit push across schools, state, university, and local buildings—measures that are “implementation-ready” and historically high-ROI in Alaska's climates.

In Unalaska—where grid electricity is currently diesel-based—weatherization before electrification avoids load growth that would otherwise still be petroleum-fueled.

Targeted actions:

- Scale weatherization (insulation, air sealing, windows, ventilation/IAQ) for rentals, employer-provided housing, and elder housing, using AHFC WAP + Rebates; bundle language access and concierge assistance to reach Limited English Proficiency (LEP) (9.4%) households.
- Public building retro-commissioning & HVAC upgrades (schools/clinics/municipal) to cut diesel heat and generator run-time; add heat-recovery ventilation to improve IAQ.
- Phased fuel switching to high-efficiency electric (e.g., heat pumps) after supply-side renewable progress and envelope work to avoid increasing diesel generation.

Implications: Weatherization reduces utility bills and mold/moisture risks, directly supporting households with limited incomes and insurance gaps (14.8% uninsured); school and clinic upgrades lower operating costs and improve comfort/health for high-use community spaces.

**Transportation & working waterfronts**

Transportation is 12.36% of local emissions, dominated by trucks (95% of vehicle CO<sub>2</sub>e), while the community economy is marine-oriented. That points to two lanes: (1) pragmatic fleet efficiency and cleaner fuels for trucks and equipment; and (2) electrification at the docks/harbors (shore power for large vessels where loads and utility capacity make sense; e-equipment for cargo/yard operations). The Priority Plan highlights EVSE deployment, port shore-power models, and diesel-emission reduction programs that can be adapted from cruise-port pilots to fishing/commercial docks.

Targeted actions:

- Freight & municipal fleets: right-size vehicles, idle-reduction tech, hybridization/EV where duty cycles fit; pair with Level 3 + Level 2 charging at municipal yards and key freight nodes.
- Harbor electrification: extend the shore-power concept to priority berths (cold-ironing for long-dwelling vessels, electrified ship services) as local generation cleans; add electric yard equipment (forklifts, reefers).
- Safe walking/busing investments to cut short truck/passenger trips; coordinate with disaster routes given flood exposure (13% of properties).

Implications: Cleaner docks and truck routes reduce exposure for nearby neighborhoods and workers, improving respiratory outcomes where asthma (7.1%) and poor mental health (10.4%) are concerns; charging access in town reduces ownership barriers for lower-income drivers over time.

**Waste & materials management**

While local solid waste/wastewater emissions weren't included in the Unalaska dataset, statewide measures in the Priority Plan (e.g., landfill methane capture, regional composting) show large, near-term reductions and cost control—relevant for island logistics and storm disruptions. These can be pursued via regional partnerships and right-sized local pilots (organics diversion from institutions; improved wastewater aeration efficiency).

**Targeted actions:**

- Organics diversion / composting for schools, seafood processors, and large generators to shrink waste volumes and barge costs; explore biochar/soil amendments for local applications. priority plan
- Wastewater energy upgrades (blowers/controls, potential heat recovery) modeled on state examples to trim electricity use until the grid is cleaner.

Implications: Lower system costs can restrain rate increases; reduced open-bin organics and better WWTP operations improve local environmental conditions in neighborhoods with higher renter density and language barriers.

**Industrial & commercial efficiency**

With industrial sources the single largest contributor locally, process and facility efficiency is a high-leverage space: thermal efficiency in processing, electrified drives where feasible, on-site PV/storage for facilities, and waste-heat capture paired with building loads. State programs anticipate non-residential retrofits and community generation partnerships that municipalities and Tribes can sponsor alongside private operators.

**Targeted actions:**

- Heat recovery + load matching (e.g., from generators/process equipment to space/water heat in public or commercial buildings).
- Electrify auxiliary systems (pumps, compressors, refrigeration) as renewables arrive; add smart controls and sub-metering to verify savings.

Implications: Lower operating costs stabilize local jobs and prices; co-located public benefits (heating community buildings with recovered heat) distribute gains beyond private facilities.

**Improved Outcomes for Overburdened and Underserved Communities**

In Unalaska, the mitigation strategies outlined offer multiple pathways to better outcomes that go beyond emissions reductions—especially for low-income households, residents with limited English proficiency, and others facing systemic barriers. Weatherization and efficiency upgrades directly cut household energy bills and improve indoor air quality, which is critical in aging rental housing and for residents with higher rates of asthma, hypertension, and diabetes.

Energy transition measures—such as adding renewable generation and reducing diesel use—promise longer-term cost stability and resilience by lowering exposure to fuel price swings that hit cost-sensitive households hardest. Public facility retrofits, particularly in schools and clinics, improve comfort and the reliability of essential services, benefiting uninsured residents and anyone who depends on public infrastructure. In transportation and harbor operations, cleaner fleets and shore power reduce localized diesel exposure, directly improving the health and working conditions of harbor workers and nearby renters. Even less

visible strategies—like improved waste management and industrial heat recovery—deliver cost relief and healthier neighborhood environments by cutting odors, pests, and utility expenses. Together, these measures address overlapping vulnerabilities—economic strain, health burdens, housing pressures, and environmental risks—ensuring emissions reduction actions also produces tangible improvements in daily life for energy-burdened households across the Aleutians West region.





**Benefit (Disbenefit) Quantification or Qualitative Analysis****Energy Transition & Community Power (renewables, storage, diesel optimization, waste-heat)**

| Outcome             | Potential Impact   | Quantitative / Qualitative Assessment                                                                                                                                                                                                                          | Community Benefits                                                                                                                                           |
|---------------------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High               | Petroleum supplies ~100% of local electricity (~15% of total GHGs). Near-to-mid term diesel optimization + 20–40% renewable penetration could cut power-sector emissions ~20–50%, equal to ~3–8% of total community emissions; higher with deeper penetration. | Reduced community-wide emissions and local combustion exposure; visible public benefits even for renters and LEP households via lower public-facility loads. |
| Energy cost savings | High (medium ramp) | Displacing diesel (fuel + logistics) moderates volatility; levelized costs improve as renewables scale. Community bills feel effects through rates and public-facility savings; near-term savings rise with waste-heat recovery.                               | Lower bills and more stable rates benefit cost-sensitive households; community ownership models can recycle savings into assistance programs.                |
| Health benefits     | Moderate–High      | Less on-island diesel generation reduces combustion byproducts; combined with building upgrades, improves indoor/outdoor air quality.                                                                                                                          | Benefits accrue to neighborhoods near generators and to users of public buildings (schools/clinics) heavily used by uninsured/low-income residents.          |
| Resilience          | High               | Storage + diversified supply reduces outage risk; waste-heat improves heating security; fewer fuel deliveries during storms.                                                                                                                                   | Outage mitigation favors households with limited resources to self-insure; critical for elders, children, and shift workers.                                 |
| Disbenefits / risks | Moderate           | Capital intensity; intermittency if poorly sized; rate design risk if costs socialized before savings materialize; workforce constraints.                                                                                                                      | If not designed equitably, upfront costs could translate to higher rates; ensure low-income protections and community benefit agreements.                    |





### Buildings: Weatherization & Efficiency First (then targeted fuel switching)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                   | Community Benefits                                                                                                             |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Stationary combustion dominates community emissions; deep envelope + HVAC/controls can trim 20–40% of building fuel use. Order-of-magnitude: ~5–10% of total emissions with strong uptake across residential + public/commercial stock. | Renters (majority) gain if programs include tenant protections; employer-/fleet housing and elder housing see immediate gains. |
| Energy cost savings | High (immediate) | Typical whole-home/commercial retrofits deliver ~15–30% bill reductions; ventilation/controls add persistence.                                                                                                                          | Direct, near-term bill relief for low-income tenants; translated outreach + concierge support crucial for LEP households.      |
| Health benefits     | High             | Better IAQ, moisture/mold reduction, thermal comfort; supports residents with elevated asthma, hypertension, and diabetes.                                                                                                              | Disproportionate benefits for overcrowded or older rentals; improved school/clinic environments help uninsured and youth.      |
| Resilience          | Moderate–High    | Tighter envelopes sustain safe indoor temps during outages; load reduction lowers peak stress on local grid.                                                                                                                            | Reduces need for costly backup solutions in low-income homes; better indoor conditions during storms.                          |
| Disbenefits / risks | Moderate         | Split incentives in rentals; retrofit disruption; risk of rent increases if incentives don't protect tenants; contractor capacity limits.                                                                                               | Without renter safeguards and no-cost options, low-income households risk exclusion or cost pass-throughs.                     |



**Transportation & Harbors (truck/fleet efficiency, EVs where feasible, shore power, e-yard equipment)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                          | Community Benefits                                                                                                             |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Transportation ~12% of total; focused measures on trucks (~95% of vehicle CO <sub>2</sub> e) + harbor electrification can cut ~10–30% of that sector in phases (~1–4% of total), growing as grid gets cleaner. | Air-quality gains for harbor workers and renters near docks/depots; quieter operations improve neighborhood conditions.        |
| Energy cost savings | Moderate         | Fleet right-sizing/idle-reduction yield immediate fuel savings; EV TCO favorable on some duty cycles; shore power reduces vessel fuel use during berths.                                                       | Lower operating costs can stabilize service prices; equitable public charging lowers barrier for low-income drivers over time. |
| Health benefits     | Moderate         | Less diesel exhaust near harbors/arterials; fewer short-trip cold starts with mode shift options.                                                                                                              | Direct exposure reduction for workers and adjacent renter communities; supports respiratory outcomes.                          |
| Resilience          | Moderate         | Less dependence on liquid fuels; diversified fueling (electric) can hedge supply disruptions; requires grid readiness.                                                                                         | Critical workers keep moving during fuel shortages; public charging at civic sites aids residents without home charging.       |
| Disbenefits / risks | Moderate         | High vehicle capex; charging build-out; benefits limited until power decarbonizes; risk of early adopter inequity.                                                                                             | If incentives aren't income-targeted, higher-income users benefit first; ensure low-income EVSE access and used-EV pathways.   |

**Public & Community Facility Retrofits (schools, clinics, municipal)**

| Outcome             | Potential Impact        | Quantitative / Qualitative Assessment                                                                                                  | Community Benefits                                                                                              |
|---------------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate                | Public buildings are smaller share of total but have long hours and steady loads; 20–35% reductions common; visible leadership effect. | Indirect household benefits via lower municipal/clinic operating costs and community comfort.                   |
| Energy cost savings | High                    | Retro-commissioning, HVAC upgrades, controls can deliver persistent savings; frees budget for services.                                | Savings can support expanded services or rate relief benefitting low-income and uninsured residents.            |
| Health benefits     | High (co-benefit)       | Better ventilation, filtration, and thermal comfort in high-occupancy spaces (schools/clinics).                                        | Improves conditions where households rely on public services; supports student performance and clinic outcomes. |
| Resilience          | High (community anchor) | Facilities can serve as clean, warm/cool shelters; backup integration pairs well with storage.                                         | Reliable gathering points during outages for households lacking alternatives.                                   |
| Disbenefits / risks | Low–Moderate            | Capital funding and project delivery capacity; potential construction disruption.                                                      | Schedule work to avoid service interruption; ensure accessibility during retrofits.                             |

**Industrial & Commercial Efficiency (process heat, electrified drives, heat recovery, controls)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                               | Community Benefits                                                                                                          |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Industrial activity is the single largest slice of emissions. 10–25% sector reductions from process optimization, heat recovery, and electrified auxiliaries could yield ~3–9% of total reductions. | Big local reductions where people live/work; if waste heat is shared to heat public/community buildings, benefits multiply. |
| Energy cost savings | High             | Process efficiency + heat recovery produce material OPEX cuts; faster paybacks in fuel-intensive operations.                                                                                        | Stabilizes employment and local prices; potential funding for community benefit agreements.                                 |
| Health benefits     | Moderate         | Lower combustion and improved filtration reduce on-site exposures; indirect community air benefits.                                                                                                 | Supports worker health and neighboring renter areas near industrial zones.                                                  |
| Resilience          | Moderate–High    | Reduced fuel dependence; thermal networks/heat recovery provide backup for community loads.                                                                                                         | Community facilities connected to recovered heat gain secure heating during disruptions.                                    |
| Disbenefits / risks | Moderate         | Requires private investment and data transparency; risk of uneven benefit distribution if savings not shared.                                                                                       | Tie incentives to public co-benefits (heat sharing, workforce training).                                                    |

**Waste & Materials Management (organics diversion/composting, wastewater energy upgrades)**

| Outcome             | Potential Impact       | Quantitative / Qualitative Assessment                                                                                                                                 | Community Benefits                                                                                |
|---------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate (growing) | Direct share of community inventory is smaller, but methane avoidance is high-value; institutional organics + landfill practices can notch measurable cuts over time. | Broad, diffuse benefits; complements other strategies.                                            |
| Energy cost savings | Moderate               | Reduced waste volumes lower barge/handling costs; wastewater aeration/controls cut electricity use at plants.                                                         | Rate stability helps cost-burdened households; municipal savings can support assistance programs. |
| Health benefits     | Moderate               | Less odor/vermin; cleaner handling; reduced open-bin attractants.                                                                                                     | Improves neighborhood conditions in dense rental areas.                                           |
| Resilience          | Moderate               | Local organics handling reduces dependence on shipping; biosolids/compost products support local uses.                                                                | Fewer service disruptions impact households that cannot afford alternatives.                      |
| Disbenefits / risks | Low–Moderate           | Behavior change and logistics; small early impacts; siting concerns.                                                                                                  | Design programs with multilingual education and no-cost starter kits to ensure participation.     |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household costs: Reduced energy use and improved efficiency lower utility bills, directly benefiting low-income households with limited financial flexibility.
- Improved health outcomes: Decreased diesel reliance reduces respiratory irritants, supporting better outcomes in communities with high asthma, hypertension, and diabetes rates.
- Greater housing comfort & safety: Weatherization and ventilation upgrades improve indoor air quality, reduce mold/moisture issues, and extend the lifespan of older or substandard rental housing.
- Enhanced access to services: Retrofits in schools, clinics, and municipal buildings strengthen critical infrastructure, directly benefiting uninsured or under-resourced populations.
- Resilience in disasters: Lower dependence on imported diesel and stronger local energy systems improve recovery capacity for communities already facing high flood and extreme weather risk.
- Workforce and economic stability: Efficiency upgrades and industrial improvements support job stability and open local training opportunities, reducing vulnerability among modest-income workers.
- Neighborhood quality improvements: Cleaner harbors, reduced waste odors/vermin, and quieter operations improve the daily environment for renters living in high-density housing.
- Inclusive program design potential: Multilingual outreach and renter protections ensure Limited English Proficiency (LEP) households and tenant populations are not excluded from program benefits.

Potential disbenefits if not designed equitably:

- Upfront costs & access barriers: Without subsidies or renter protections, landlords may pass retrofit costs onto tenants, potentially raising rents.
- Technology accessibility gaps: EVs, solar, and advanced equipment may initially benefit higher-income residents unless access programs are tailored for vulnerable households.
- Program complexity: Application processes may disadvantage households with limited English proficiency (9.4% of the population) unless intentionally simplified.
- Unequal benefit distribution: Industrial efficiency and harbor electrification may primarily support commercial operators unless public co-benefits (e.g., shared heat recovery, community shore power access) are built in.
- Transition risks: If electrification outpaces renewable deployment, households could face higher costs from petroleum-based grid electricity in the near term.
- Community trust & participation: Past infrastructure or defense-site legacies may cause skepticism; ensuring transparency and visible benefits will be critical.

### Path Forward

The path forward for Unalaska requires sequenced, community-driven action that aligns emissions reduction goals with daily improvements for residents:

- **Near-Term (1–3 years):** Prioritize weatherization and efficiency upgrades for housing and public facilities. These measures are immediately implementable, deliver rapid cost savings, and improve comfort and health outcomes—especially for renters and uninsured residents. At the same time, begin diesel plant optimization and waste-heat recovery to reduce emissions from existing power systems while preparing for renewable integration.
- **Mid-Term (3–7 years):** Scale renewable energy generation with storage to replace petroleum-based electricity, supported by community solar programs and local grid modernization. Advance fleet efficiency measures and deploy public EV charging infrastructure, with a focus on municipal vehicles, freight yards, and harbors. Expand shore power at priority berths to cut harbor emissions and improve air quality for workers and nearby households.



- **Long-Term (7+ years):** Transition toward phased electrification of heating and transport as renewables scale up, ensuring new loads are powered by clean sources. Pair this with industrial efficiency upgrades and heat recovery systems that can provide shared benefits to community buildings. Advance waste management innovations (composting, wastewater efficiency) to reduce costs and strengthen resilience against supply chain disruptions.

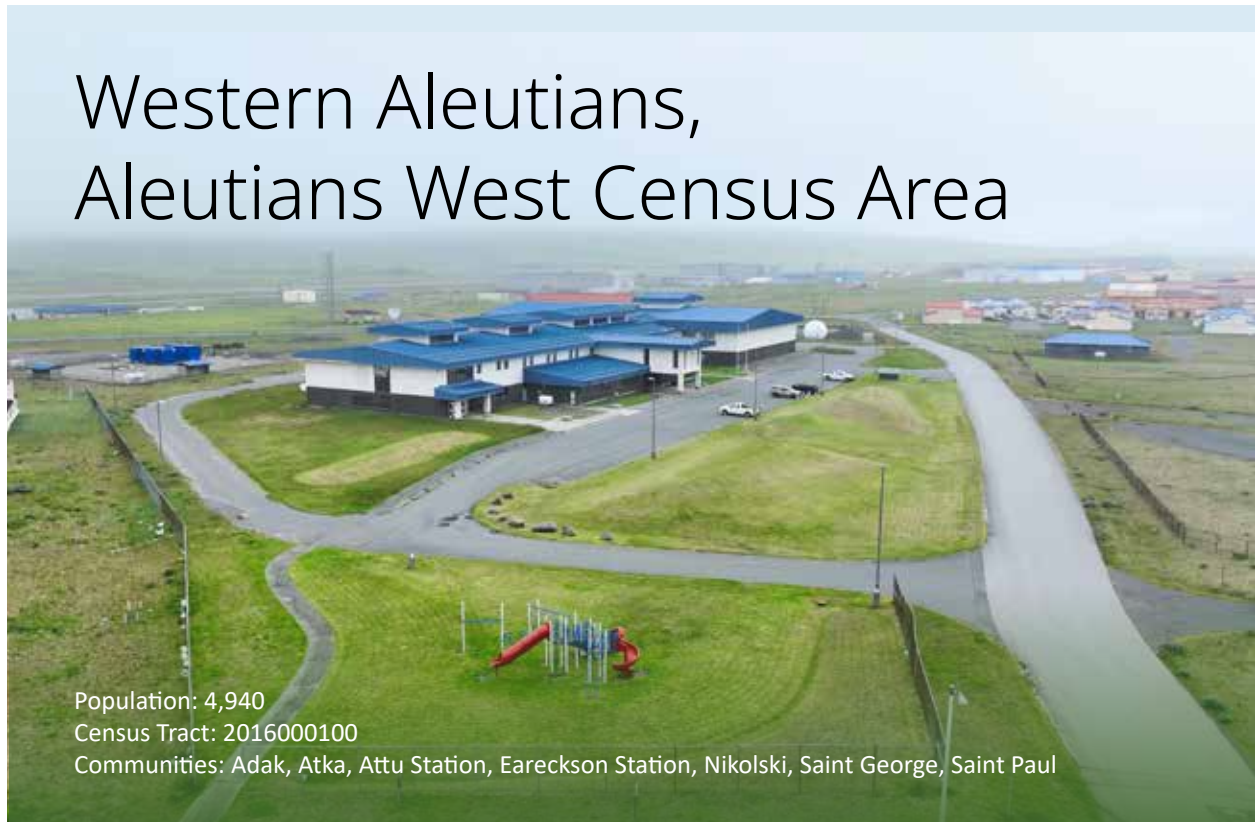
Throughout, inclusive program design will be critical: embedding renter protections, multilingual outreach, and accessible financing ensures that vulnerable households can fully participate and benefit. Workforce development and local training should be prioritized to keep investment and job creation within the community.

By pursuing this pathway, Unalaska can align with Alaska's broader Sustainable Energy Action Plan while achieving local goals: lowering emissions, reducing household burdens, improving public health, and strengthening resilience in the face of environmental and economic risks. This roadmap emphasizes sustainability action as community action—ensuring that the most vulnerable households see tangible benefits first, while building a durable foundation for the region's clean energy transition.





# Western Aleutians, Aleutians West Census Area



The Aleutians West Census Area, Tract 1, faces a unique convergence of environmental, health, and socioeconomic challenges that shape both its current conditions and its pathways for sustainability action. The region's emissions profile is dominated by stationary fuel oil use, petroleum-based electricity generation, and truck-dependent transportation, placing significant pressure on households, local infrastructure, and natural systems. At the same time, social determinants of health—such as high rates of chronic illness, extreme energy burdens, and limited insurance coverage—create vulnerabilities that amplify the impacts of environmental risks.

These dynamics make Aleutians West both a high-priority and high-opportunity region for emissions reduction planning. By focusing on strategies that cut emissions while also improving daily living conditions, the community can achieve dual benefits: lowering air quality emissions and strengthening resilience for its most vulnerable populations. This roadmap draws from state priorities, regional data, and local conditions to identify the strategies that offer the greatest impact.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Deep Weatherization of Homes and Public Building Retrofits
2. Hybrid Microgrids with Renewables and Storage
3. Port and Non-Road Diesel Reductions (Electrification + Retrofits)

Together, these three strategies cover household, community infrastructure, and industrial/transportation domains—making them the highest-leverage interventions for both emissions reduction and improved outcomes in overburdened and underserved communities. Weatherization + retrofits deliver the fastest health and affordability improvements. Hybrid microgrids unlock systemic decarbonization and energy security. Port and non-road diesel measures clean up the most concentrated sources of local pollution exposure.

## Emissions Data Overview

Note that the Aleutians West Census area contains two census tracts. The modeled emissions data are for the entire area.

Total Modeled Emissions: 79,566 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (77.51%)

- Residential (21.8% of total)
  - Residual Fuel Oil No. 5: 15,799 mt CO<sub>2</sub>e (dominant source, 19.86% of community total).
  - Electricity: 1,238 mt CO<sub>2</sub>e (1.56%).
  - Natural Gas: 185 mt CO<sub>2</sub>e (0.23%).
  - Propane: 101 mt CO<sub>2</sub>e (~0.1%).
  - Wood & Wood Residuals: 1 mt CO<sub>2</sub>e (negligible).
- Commercial Sector (19.19%)
  - Electricity: 10,399 mt CO<sub>2</sub>e (13.07%)
  - Distillate Fuel Oil No. 1: 4,508.89 mt CO<sub>2</sub>e (5.67%)
  - Propane: 344.21 mt CO<sub>2</sub>e (0.43%)
  - Wood & Wood Residuals: 12.51 mt CO<sub>2</sub>e (0.02%)
- Industrial Sector: 36.6%.
  - 19,084.86 mt CO<sub>2</sub>e (36.55%)

### Transportation (22.5%)

- Motor Gasoline (main contributor 14,340 mt CO<sub>2</sub>e (18.02%)
- Diesel Fuel: 3,551 mt CO<sub>2</sub>e (18.02%)
- Electricity (vehicles): 0.19 mt CO<sub>2</sub>e (negligible)

In terms of vehicle types:

- Trucks: 17,080.73 mt CO<sub>2</sub>e (95.47%)
- Passenger vehicles: 788.66 mt CO<sub>2</sub>e (4.41%)
- Motorcycles: 21.85 mt CO<sub>2</sub>e (0.12%)

### Electricity Generation

- Total electricity consumption: 46,446.54 MWh
  - Petroleum-fueled generation: 40,408.49 MWh → 11,637.65 mt CO<sub>2</sub>e (100%)
  - Hydro 6,038.05 MWh → 0.00 mt CO<sub>2</sub>e (0.00%)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

Solid waste and wastewater emissions were not included in this dataset.

### Key Takeaways

- Industrial reliance on fuel oil is the largest emissions source — a key target for reductions.
- Residential heating depends heavily on residual fuel oil, suggesting opportunities for cleaner alternatives.
- Petroleum-based electricity generation is a significant driver; expanding hydro or renewables could reduce emissions.
- Transportation is dominated by trucks using gasoline and diesel, highlighting potential gains from efficiency or electrification.

## Social Determinants of Health

### Environmental Conditions

- High anticipated changes in extreme weather (82nd percentile nationally) signal the region is particularly vulnerable to environmental-related disruptions.
- Annualized disaster loss (~\$827,000; 47th percentile) shows moderate disaster risk, though the costs relative to population size may strain recovery capacity.
- Air quality risks are present: diesel particulate matter exposure and air toxics cancer risk (8th percentile nationally) may exacerbate respiratory and chronic illnesses.
- Proximity to hazardous sites (Superfund 64th percentile; RMP facilities 70th percentile) increases potential exposure to toxic releases and environmental hazards.
- Legacy housing stock (pre-1980s at 87th percentile) suggests older, less efficient homes with greater health and safety risks.
- Low transportation and flood exposure reduces some physical risks but limits mobility resilience.

Implications: Environmental risks intersect with aging housing and pollution sources, potentially compounding health burdens. These factors highlight the importance of aligning pollution reduction with disaster resilience and housing improvement.

### Public Health Indicators

- Asthma prevalence (9.4%, 85th percentile) and diabetes prevalence (12%, 100th percentile) show particularly high chronic disease burdens.
- High blood pressure (34%, 96th percentile) and poor mental health prevalence (13%, 91st percentile) indicate significant stressors and long-term health risks.
- Cancer prevalence (4.5%, 74th percentile) and heart disease (55th percentile) add further complexity to community health needs.
- Average life expectancy (76 years) is below national norms, aligning with a 73rd percentile ranking for low life expectancy.

Implications: Elevated chronic disease rates and mental health concerns reflect structural vulnerabilities that can be worsened by environmental stressors. Emissions reduction policies will need to account for these public health realities to avoid unintended burdens on already at-risk populations.

### Socioeconomic Factors

- Poverty (27% under 200% Federal Poverty Level (FPL); 60th percentile) and low educational attainment (7% without high school diploma) reflect moderate economic challenges.
- Unemployment is low (2%), but housing insecurity is high: 41% renter-occupied (68th percentile) and housing stock of low median value (\$71,500; 6th percentile).
- Insurance gaps are severe (33% uninsured; 98th percentile), leaving many without health coverage.
- High energy burden (8%; 98th percentile) and limited internet access (25%; 84th percentile) demonstrate resource inequities.
- Demographics: 12% of the population is over 65 (100th percentile), 16% live with disabilities (77th percentile), and limited English proficiency is present (2%; 75th percentile).
- Transportation access score of 0 indicates extreme mobility challenges.

Implications: Limited financial resilience, high uninsured rates, and costly energy needs create barriers to adopting new systems or technologies. These socioeconomic pressures will influence how feasible and acceptable sustainability-related changes appear to residents.

### Intersection with Emissions Reduction Planning

- **Environmental vulnerability and aging infrastructure:** The community's high exposure to extreme weather and hazardous sites, combined with older housing stock, means pollution reduction planning must also strengthen resilience. Efforts to reduce emissions may need to be bundled with investments in housing upgrades and hazard mitigation to avoid widening disparities.
- **Public health burdens:** Elevated rates of asthma, diabetes, hypertension, and poor mental health point to populations already sensitive to environmental stressors. Pollution reduction initiatives will need to account for these conditions, ensuring that interventions do not unintentionally increase health risks (e.g., through higher costs, displacement, or disruptions in care).
- **Socioeconomic constraints:** High uninsured rates, significant energy burdens, and limited access to internet or transportation restrict the community's ability to absorb transition costs. Emissions reduction strategies will need to consider affordability, accessibility, and equitable distribution of benefits.
- **Demographic considerations:** The high proportion of older adults and residents with disabilities highlights the need for inclusive planning. Without targeted support, these groups may be excluded from or even harmed by transitions to new energy systems or infrastructure changes.

**Implications:** Successful emissions reduction in Aleutians West will require integrated planning that recognizes social vulnerabilities alongside environmental goals. By aligning emissions reductions with improvements in housing, health equity, and economic resilience, the community can advance both environmental and social well-being outcomes.

### Mitigation Strategies

#### Transportation

Aleutians West's mobility needs are dominated by marine and air, with limited road mileage between communities. The biggest near-term wins come from cleaning up the equipment and hubs that move people, fish, and freight.

- **Harbor & port electrification (shore power + yard equipment):** Dutch Harbor/Unalaska is a major working port; providing shore power and electrifying harbor equipment reduces diesel runtime and local air pollution where people live and work.
- **Right-sized fleet electrification:** Focus early EVs on municipal/utility light fleets, school/activity buses, and health/outreach vans that have predictable routes and depot charging. The PSEAP contemplates EVSE installation programs that can underwrite the charging backbone needed for these targeted fleets.
- **Non-road diesel reductions:** Expand clean-diesel retrofits or replacements (construction equipment, airport ground support, fish-processing forklifts). This fits PSEAP's AEA DERA/VEEP and rural distribution programs and directly addresses local diesel PM exposure.

#### Buildings & Energy Transition (Homes and Public Facilities)

With residential fuel oils heavily used and electricity still largely petroleum-generated in the area, the most effective steps are to cut thermal demand first, then electrify where the grid can support it or as local renewables come online.

- **Deep weatherization first, at scale:** Prioritize air sealing, insulation, ventilation, and heating system tune-ups through AHFC-style programs. The PSEAP details strong, proven statewide benefits—reduced fuel purchases, fewer moisture/mold issues, and more resilient homes when barge/air deliveries are delayed.
- **Public building retro-commissioning and retrofits:** Schools, clinics, and local government buildings can be upgraded quickly (controls, HVAC, envelope, beneficial electrification where economical). PSEAP flags these as implementation-ready and cost-effective in rural districts.
- **Targeted beneficial electrification (heat pumps):** Deploy first in buildings with strong envelopes and in microgrids where renewable penetration/storage is growing. The PSEAP supports residential beneficial electrification where lifecycle performance makes sense.



### Electricity & Microgrids

Communities in the Aleutians rely on isolated systems with significant diesel generation. The region can unlock much larger benefits from building electrification and EVs if the supply gets cleaner and more reliable.

- Hybrid microgrids with storage (“diesels-off” capable): Incremental wind/solar coupled with storage and advanced controls can displace diesel hours, cut volatility, and improve resilience—an approach highlighted in the PSEAP with case studies demonstrating substantial fuel and cost savings.
- Grid-bridging and controls upgrades: Investments in high-power, short-duration storage (e.g., ultracapacitors/LTO) can provide reserves and frequency regulation to enable higher renewable penetration on small systems.
- Community renewable generation via AEA/REF/Solar for All: Pair new generation with weatherization and demand-side measures so added kWh displace the most expensive/diesel-intensive loads.

### Waste & Materials

While solid waste isn’t the dominant emissions source for Aleutians West, organics diversion and methane management can be meaningful co-benefits, especially where landfills serve dense seasonal populations.

- Organics diversion/composting where feasible: Modeled statewide measures show meaningful CO<sub>2</sub>e cuts and public-health co-benefits. For Aleutians West, right-size pilots (fish waste, food scraps) could reduce hauling and nuisance emissions.
- Waste heat & process integration: In communities with fish processing, explore capturing low-grade heat for district or facility loads, coordinated with microgrid planning.

### Health-Forward Targeting & Workforce

- Health-informed targeting: Prioritize weatherization and indoor-air upgrades for elders and medically vulnerable households first. This aligns with PSEAP’s framing of near-term, implementation-ready measures that improve community conditions rapidly.
- Local workforce & contractor capacity: Pair projects with place-based training, wraparound supports, and contractor ecosystem development called out in the PSEAP—so funds convert into durable local jobs and timely delivery in remote settings.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes for communities in Aleutians West can be realized through strategies that directly reduce household energy burdens, improve local air quality, and strengthen resilience in public services. Deep weatherization and targeted electrification of homes address high heating costs and poor indoor conditions, delivering immediate relief to households already struggling with high medical burdens and limited insurance coverage. Port and non-road diesel reductions lessen particulate matter exposure where residents live and work, reducing risks for asthma and cardiovascular disease that are already elevated in the region. Clean, reliable microgrids paired with renewable generation help stabilize electricity costs and reduce dependence on diesel shipments, providing security for households facing economic and geographic isolation. Finally, investing in local workforce capacity ensures that the transition generates durable jobs and income within the community, creating a multiplier effect that supports both economic resilience and health. Together, these measures not only lower emissions but also improve daily living conditions and long-term health trajectories for residents.

**Benefit (Disbenefit) Quantification or Qualitative Analysis****Transportation Strategies (Harbor & Port Electrification, Right-Sized Fleet Electrification, Non-Road Diesel Reductions)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                         | Community Benefits                                                                                    |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| GHG Reduction       | Moderate         | Port electrification and fleet changes can reduce diesel/gasoline emissions (~22% of local emissions are transport-related). Estimated reductions could reach several thousand mt CO <sub>2</sub> e annually. | Reduces concentrated diesel use near communities, lowering disproportionate exposure.                 |
| Energy Cost Savings | Moderate         | EV fleets reduce long-term O&M costs; port electrification avoids idling fuel costs. Savings depend on electricity costs vs. diesel.                                                                          | Lower operating costs for public fleets can improve service delivery in communities.                  |
| Health Benefits     | High             | Significant reductions in particulate matter at ports and workplaces; improvements in respiratory health outcomes.                                                                                            | Direct relief for workers and nearby residents, where asthma prevalence is ~85th percentile.          |
| Resilience          | Moderate         | Cleaner fleets and shore power enhance operational reliability but depend on electricity infrastructure.                                                                                                      | Improves reliability of critical services (public transit, school buses) for underserved groups.      |
| Disbenefits/Risks   | Moderate         | High upfront costs; infrastructure deployment challenges; seasonal demand variability at ports.                                                                                                               | Risk of limited access if subsidies or incentives are not structured to reach underserved households. |

**Buildings & Energy Transition (Deep Weatherization, Public Building Retrofits, Targeted Electrification)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                      | Community Benefits                                                                 |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| GHG Reduction       | High             | Weatherization reduces heating fuel demand; residential fuel oil is ~20% of total emissions. Retrofit savings could cut thousands of mt CO <sub>2</sub> e. | Reduces fossil fuel dependency in homes most reliant on expensive residual oil.    |
| Energy Cost Savings | High             | Weatherization and retrofits typically yield 20–40% energy savings; especially impactful given local 98th percentile energy burdens.                       | Largest affordability benefit for low-income renters and homeowners.               |
| Health Benefits     | High             | Improved indoor air quality, less mold/moisture, reduced cold-related triggers.                                                                            | Benefits households with high chronic disease prevalence (hypertension, diabetes). |
| Resilience          | High             | More durable housing and public facilities; reduced exposure to extreme cold and fuel delivery disruptions.                                                | Critical for elders (65+ at 100th percentile) and medically vulnerable.            |
| Disbenefits/Risks   | Low              | Upfront costs; need for skilled labor and program access.                                                                                                  | If programs are not accessible, some households could be left out of improvements. |

**Electricity & Microgrids (Hybrid Microgrids, Grid Upgrades, Community Renewables)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                     | Community Benefits                                                                |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| GHG Reduction       | High             | Displacing diesel generation (11,600+ mt CO <sub>2</sub> e from petroleum-based electricity) with renewables/storage has major potential. | Ensures cleaner electricity for homes and community services.                     |
| Energy Cost Savings | High             | Reduced reliance on volatile diesel deliveries; stabilization of long-term electricity rates.                                             | Eases high cost burdens, especially for residents with limited incomes.           |
| Health Benefits     | Moderate         | Reduced diesel exhaust emissions and indoor air improvements as heating/electricity systems transition.                                   | Directly improves respiratory outcomes for vulnerable groups.                     |
| Resilience          | High             | Hybrid systems reduce outage risks, stabilize grids, and support electrification.                                                         | Protects essential services (health, education, water systems) in isolated areas. |
| Disbenefits/Risks   | Moderate         | Capital intensive; O&M requires local capacity; integration challenges.                                                                   | Without local workforce development, benefits may not reach vulnerable groups.    |

**Waste & Materials (Organics Diversion, Waste Heat Integration)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                            | Community Benefits                                                                  |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| GHG Reduction       | Low              | Limited contribution relative to other sectors; organics diversion reduces methane, but overall impact is small. | Still provides co-benefits at community scale.                                      |
| Energy Cost Savings | Low to Moderate  | Waste heat recovery can offset facility heating costs; composting reduces disposal costs modestly.               | Potential savings for local institutions serving energy-burdened residents.         |
| Health Benefits     | Moderate         | Reduces odors, pests, and nuisance burning; improved local environmental quality.                                | Enhances living conditions near waste sites, often affecting vulnerable households. |
| Resilience          | Moderate         | Local compost supports food security; waste heat can improve industrial efficiency.                              | Supports community resilience in resource-limited settings.                         |
| Disbenefits/Risks   | Low              | Requires participation, processing capacity, and coordination with industries.                                   | If costs fall on households, vulnerable groups may not engage.                      |

**Health-Forward Targeting & Workforce**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                     | Community Benefits                                                   |
|---------------------|------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| GHG Reduction       | Indirect         | Not a direct emissions strategy, but amplifies the effectiveness of other interventions.  | Ensures emissions cuts benefit vulnerable groups.                    |
| Energy Cost Savings | Moderate         | Prioritizing underserved households ensures those with highest burdens see relief first.  | Direct affordability gains where burdens are extreme.                |
| Health Benefits     | High             | Targets vulnerable populations with upgrades that improve indoor health conditions.       | Critical for households with elevated chronic disease prevalence.    |
| Resilience          | High             | Workforce training builds local capacity for long-term system maintenance and adaptation. | Provides income stability in communities with limited job diversity. |
| Disbenefits/ Risks  | Low to Moderate  | Requires consistent funding and project pipelines to sustain workforce.                   | If programs lapse, vulnerable groups may lose out on benefits        |

**Cross-Cutting Community Benefits and Disbenefits**

Across all strategies, benefits for community benefits include:

- Energy affordability: Weatherization, microgrids, and renewable generation directly reduce household energy burdens, which are among the highest in the nation for this tract.
- Health improvements: Reduced diesel emissions (ports, fleets, non-road equipment) and better indoor air from efficient homes lower risks for asthma, hypertension, and cardiovascular disease—conditions disproportionately high in the community.
- Service reliability: Upgrades to public buildings and microgrids improve stability in schools, clinics, and essential infrastructure, providing more consistent access to services relied on by low-income residents.
- Economic resilience: Workforce programs and local contractor development expand job opportunities, helping households stabilize incomes in a region where costs are high and labor is often imported.
- Environmental quality: Organics diversion, waste heat recovery, and cleaner transport options reduce local pollution burdens and improve living conditions in areas adjacent to industrial and waste facilities.

Potential disbenefits if not designed equitably:

- Upfront costs: High capital expenses for electrification, grid upgrades, and weatherization can limit participation for households without subsidies or financing.
- Capacity constraints: Many strategies require skilled labor and technical expertise, which may be scarce in remote areas, delaying implementation for vulnerable communities.
- Technology dependence: Electrification and grid upgrades depend on cleaner electricity supply; without sufficient renewable penetration, benefits may be muted while costs rise.
- Participation barriers: Programs requiring applications, documentation, or co-financing may be harder for some households to access, especially with limited internet and high uninsured rates.
- Sustainability of efforts: Long-term operation and maintenance of new systems (e.g., microgrids, EVSE, composting) demand consistent funding and community buy-in, which can be challenging in smaller or lower-income populations.



## Path Forward

The path forward for Aleutians West requires a coordinated approach that integrates emissions reduction with social and economic resilience. Three strategies stand out as most impactful for this region: deep weatherization and public building retrofits, hybrid microgrids with renewable energy and storage, and port/non-road diesel reductions. Together, these address the household, infrastructure, and industrial sources that account for the majority of local emissions, while also producing health and affordability benefits for residents.

Implementation will require partnership across state agencies, local governments, utilities, and community organizations. Success depends not only on the technical deployment of clean energy systems, but also on ensuring that programs are accessible, affordable, and aligned with community needs. Early actions should focus on securing funding through federal and state programs, building local workforce capacity, and piloting projects that can demonstrate quick wins—such as weatherization campaigns or targeted diesel retrofit projects.

In the long term, Aleutians West can leverage its renewable resource potential, its strategic role as a fisheries hub, and its tradition of resilience to transition toward a cleaner, more secure energy system. By advancing this roadmap, the community positions itself to reduce emissions, lower costs, and improve health outcomes, while building a foundation for sustainable economic development.





# Lower Kuskokwim, Bethel Census Area



Population: 10,929

Census Tract: 2050000100

Communities: Akiachak, Akiak, Atmautluak, Chefornak, Eek, Goodnews Bay, Kasigluk, Kipnuk, Kongiganek, Kwethluk, Kwigillingok, Mekoryuk, Mertarvik, Napakiak, Napaskiak, Newtok, Nightmute, Nunapitchuk, Oscarville, Platinum, Quinhagak, Toksook Bay, Tuluksak, Tununak

The Lower Kuskokwim region, within the Bethel Census Area of Alaska, faces a unique intersection of social, economic, and environmental challenges that shape its path toward criteria pollutants and greenhouse gas (GHG) reduction. The community is characterized by high poverty levels, significant youth populations, limited transportation and digital access, and some of the highest household energy burdens in the nation. At the same time, emissions data reveal a heavy reliance on imported petroleum fuels for residential heating, commercial and industrial energy, and electricity generation. Transportation costs and safety concerns further strain households while contributing a sizable share of local emissions.

These overlapping conditions underscore the need for strategies that not only reduce emissions but also improve health, affordability, and resilience for at-risk populations. By aligning emissions reduction actions with the most pressing social determinants of health, the Lower Kuskokwim can chart a course that delivers both environmental and community well-being. This approach ensures that mitigation strategies are not only technically sound, but also equitable, practical, and responsive to the lived realities of the region's residents.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Energy Transition in Heating (Residential & Community)
2. Housing Retrofits and Weatherization
3. Electricity Generation Shift (Petroleum to Renewables/Microgrids)

Together, these three strategies address the largest emissions sources (stationary fuel use, heating, and generation) while also directly tackling the highest burdens for at-risk households (energy costs, poor housing quality, health risks).

## Emissions Data Overview

Note that the Bethel Census area consists of three Census Tracts. These emissions data are for the entire Census Area.

Total modeled emissions: ~152,523 metric tons CO<sub>2</sub>e.

### Stationary combustion (78.9% of total emissions)

- Residential sector: ~38.8% of total emissions.
  - Residual Fuel Oil No. 5 is dominant: ~51,912 mt CO<sub>2</sub>e (~34% of total emissions).
  - Electricity, natural gas, propane, wood/wood residues make up smaller shares.
- Commercial sector: ~19.8% of total.
  - Distillate Fuel Oil No. 1 large portion (~10.84%).
  - Electricity also significant (~8.1%) in that sector.
- Industrial sector: ~20.33% of total.
  - Distillate Fuel Oil No. 2 (~31,001.89 mt CO<sub>2</sub>e) is major.

### Transportation: (21.08% of total emissions)

- Motor gasoline (~15.89% of total) is the largest, then diesel fuel.
- Trucks are the main vehicle type contributing (~94.55% of the transport emissions).

### Electricity generation:

- Almost all electricity generation emissions come from petroleum sources. ~65,767 MWh generated from petroleum in community, producing ~18,940.98 mt CO<sub>2</sub>e.
- Wind is present but contributes negligible or zero associated emissions (i.e., probably intermittent or small scale).

### Other sectors (industrial process, waste & wastewater, agriculture & land-use)

- Not included in this report.

### Key Observations / Takeaways

- The majority of emissions come from stationary combustion — heating, power generation, industrial heating — rather than transport or electricity import.
- Among stationary sources, residual fuel oil (especially No. 5) in the residential sector, and distillate fuel oils in commercial/industrial, are big carbon contributors.
- Transportation contributes a nontrivial ~21%, heavily weighted toward heavy-duty trucks and gasoline.
- Electricity generation within the county is almost entirely fossil fuel (petroleum) driven.
- Other sectors like agriculture, waste, land use are negligible in this dataset.

## Social Determinants of Health

### Environmental Conditions

- Extreme Weather & Disaster Vulnerability: Anticipated changes in extreme weather are measurable (10.8 index) and annualized disaster loss stands at ~\$535,000. This indicates the region faces tangible risks from extreme weather events.
- Pollution Exposure: Diesel particulate matter (PM), air toxics cancer risk, toxic releases, and hazardous site proximity are all near zero. While local environmental pollution is low, historical contamination is relevant since the area contains Formerly Used Defense Sites (FUDS).
- Housing & Infrastructure Risk: About 25 homes are pre-1980s, suggesting some stock may have legacy building inefficiencies, but overall housing-age vulnerability is limited. Road proximity risks are also minimal.

**Impact:** Low local pollution levels reduce immediate health risks, but environmental hazards (extreme weather, disasters) raise vulnerability. The presence of FUDS requires consideration of legacy contamination. Limited modern housing efficiency may heighten energy costs and reliance on fossil fuels.

### Public Health Indicators

- **Chronic Illness Burden:** Diabetes prevalence is moderate (4.6%) but higher in percentile terms (54.6). Heart disease ranks in the 91st percentile nationally, indicating a serious burden. Asthma and high blood pressure are also common.
- **Mental Health & Life Expectancy:** Poor mental health is present in 6% of the population (42nd percentile nationally), while life expectancy is 74 years, significantly below U.S. averages, with a low-life expectancy percentile at 86.

**Impact:** High heart disease rates and shortened life expectancy underscore health vulnerabilities. These may intensify sensitivity to environment-related stressors, such as poor air quality, disruptions in healthcare access, or increased food insecurity tied to environmental changes.

### Socioeconomic Factors

- **Poverty & Inequality:** Over half the population (54%) lives below 200% of the federal poverty line, placing the tract in the 96th percentile nationally. The GINI index is high (0.47), reflecting significant income inequality.
- **Education & Employment:** Nearly 19% lack a high school diploma (97th percentile), and unemployment is extremely high at 15.7% (99th percentile).
- **Housing & Insurance:** A fifth of households face cost burdens, median home value is \$160,900, and a quarter of residents are uninsured (94th percentile).
- **Connectivity & Demographics:** Over one-third (37%) lack internet access (95th percentile). The community skews young, with 34% under 17, and has a modest elder population (8%).

**Impact:** Severe poverty, limited education, high unemployment, and insurance gaps create barriers to participating in or benefiting from energy sustainability programs. High youth representation may demand long-term community resilience strategies, while limited internet access hampers outreach, education, and resource access.

### Transportation Insecurity

- **Access & Costs:** The transportation access score is extremely low (0.03), while transportation cost burden is very high (95th percentile).
- **Safety Risks:** Traffic fatality rates are high (87th percentile).

**Impact:** High transportation costs and low access worsen economic stress and limit ability to transition to cleaner mobility options. This will be a central challenge in implementing pollution reduction tied to energy or transportation systems.

### Intersection with Emissions Reduction Planning

The conditions above shape the context for future decisions:

- **Health Vulnerability:** High heart disease prevalence and reduced life expectancy mean that even modest increases in air pollution or disruptions from sustainability policies could have disproportionate health impacts.
- **Economic Fragility:** High poverty, unemployment, and cost burdens suggest households have little flexibility to absorb the costs of emissions reduction programs unless programs directly reduce expenses (e.g., energy efficiency, lower fuel costs).
- **Youth-Dominated Population:** A younger demographic may be more adaptable and receptive to new technologies but requires investment in education and training to ensure equitable participation.

- **Infrastructure & Access:** Limited transportation access and internet connectivity pose major obstacles to implementing statewide pollution reduction programs in this region. Tailored strategies will be needed to avoid leaving the community behind.

## Mitigation Strategies

### Energy Transition and Heating Fuels

The largest share of emissions in the Bethel Census Area comes from stationary combustion—particularly the widespread use of residual and distillate fuel oils for heating. This reliance both drives carbon output and imposes very high household energy burdens (among the highest nationally). Many homes are older and poorly insulated, further compounding fuel demand.

- Potential strategies include promoting alternatives to fuel oil heating (such as high-efficiency electric heat pumps where technically viable, or locally adapted biomass and district heating where feasible).
- Housing weatherization and efficiency retrofits would complement this shift, reducing demand regardless of fuel type.
- For at-risk households, these changes could cut heating costs, improve indoor air quality, and lower the risk of cardiovascular and respiratory health impacts linked to poor housing conditions.

### Electricity Generation and Reliability

Petroleum-fired power generation is another major emissions driver, reflecting dependence on imported fuels and limited alternatives in rural Alaska. At the same time, electricity prices are high, and many households face disproportionate cost burdens.

- Strategies in this sector could include scaling up renewable generation (wind, solar, potentially small hydro or community-scale storage) to offset petroleum use.
- Microgrids or hybrid renewable-diesel systems may provide resilience while gradually lowering emissions.
- For vulnerable communities, reducing petroleum dependence would stabilize energy costs, mitigate exposure to price shocks, and expand access to reliable power needed for health, education, and economic development.

### Transportation and Access

Transportation emissions represent about one-fifth of the region's carbon footprint, dominated by motor gasoline and heavy trucks. At the same time, residents face extreme transportation insecurity: costs are among the highest in the nation, and physical access to safe and reliable transport is limited.

- Potential strategies might emphasize investment in more efficient and lower-emission community vehicles, freight improvements, and where feasible, electrification of light vehicles or marine vessels.
- Public and shared transport solutions, even small-scale or seasonal, could provide both cost relief and emissions reduction.
- For at-risk residents, these changes could reduce household transportation costs, improve safety (given higher rates of traffic fatalities), and strengthen access to services and opportunities.

### Housing, Health, and Built Environment

The social determinants data highlight severe poverty, low education levels, and a very young population, with nearly 40% of residents under 18. At the same time, many households occupy older or lower-value housing that may not meet modern efficiency or safety standards.

- Mitigation strategies in housing should therefore focus on weatherization and retrofits as dual health and emissions interventions. These efforts can reduce heating demand, stabilize indoor temperatures during extreme weather, and directly address high rates of heart disease and respiratory illness.
- Expanding local capacity for construction and maintenance through workforce development would align with unemployment challenges while ensuring that housing upgrades can be sustained over time.

- For at-risk households, such programs would directly lower monthly costs, improve comfort and health, and prepare homes for a changing environment.

### Local Infrastructure and Access

Digital and infrastructure gaps shape the feasibility of emissions reduction strategies. Nearly 40% of residents lack internet access, and community communication systems are uneven. This can limit participation in programs and make it harder to roll out technical solutions at scale.

- Supporting infrastructure—such as community centers, schools, and tribal facilities—could serve as hubs for renewable energy, internet access, and education about clean energy programs.
- Investing in distributed, community-owned systems could ensure resilience in the face of extreme weather while reducing emissions.
- For at-risk households, strengthening community infrastructure would improve access to resources that support health, education, and participation in emissions reduction programs.

### Improved Outcomes for Overburdened and Underserved Communities

The proposed emissions reduction strategies have particular significance for vulnerable populations in the Lower Kuskokwim region. These households face disproportionate burdens from high energy costs, limited transportation options, poor housing quality, and gaps in digital and physical infrastructure. Centering emissions reduction actions around their needs will not only reduce emissions but also deliver broad improvements in health, economic security, and community resilience.

Energy transition and efficiency hold the greatest potential for direct impact. For at-risk households that spend a disproportionate share of income on fuel oil, shifting to renewable or hybrid systems and investing in weatherization would substantially reduce costs while improving indoor comfort and safety. These changes lower the risks of cold-weather exposure, improve air quality, and help households redirect scarce resources toward food, health, and education.

Transportation improvements also offer meaningful benefits. High transportation costs and limited access constrain opportunities for work, education, and health care. Cleaner and more efficient transport options—whether through shared vehicles, freight optimization, or limited electrification—would reduce costs and improve safety outcomes, particularly in communities where traffic fatality rates are above national averages.

Housing retrofits present another area where mitigation aligns with better outcomes for vulnerable populations. Many households live in older, poorly insulated homes that drive energy burdens and contribute to poor health outcomes. Investments in insulation, efficient heating, and healthier indoor environments directly address high rates of chronic disease, while also making housing more resilient to extreme weather.

Finally, strengthening community infrastructure and access ensures that at-risk populations are not left behind in the energy transition. Expanding local hubs for renewable energy, internet access, and emissions reduction program engagement allows these households to participate fully in shaping and benefiting from mitigation strategies. Over time, this builds community resilience, reduces disparities, and ensures that the region's sustainable energy roadmap translates into healthier, more equitable futures for all residents.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Energy Transition in Heating (Residential & Community)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                           | Community Benefits                                                                      |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| GHG reduction       | High             | Residential stationary $\approx 59,179$ mt. If 50% of fuel-oil heat transitions (heat pumps, biomass, district heat) with 40–70% reduction per converted home $\rightarrow \sim 11,800\text{--}20,700$ mtCO <sub>2</sub> e avoided ( $\approx 20\text{--}35\%$ of residential). | Big relief where fuel oil dominates; direct cuts where burdens are highest.             |
| Energy cost savings | High             | Heat pumps/biomass can lower delivered heat costs vs. fuel oil; typical household heating bills drop 20–50% where loads and tariffs allow.                                                                                                                                      | Reduces extreme energy burden; most helpful to low-income renters/owners.               |
| Health benefits     | Moderate–High    | Less indoor/outdoor combustion; improved IAQ; fewer cold-weather outages tied to fuel delivery.                                                                                                                                                                                 | Lowers respiratory/cardiovascular stressors; benefits children, elders.                 |
| Resilience          | High             | Diversifies from imported fuels; compatible with microgrids/storage; less exposure to price spikes and supply delays.                                                                                                                                                           | Reduces shutoff/price-shock risks that disproportionately hit at-risk households.       |
| Disbenefits/risks   | Moderate         | Upfront cost, install complexity, cold-climate performance needs, O&M workforce. Risk of uneven access without subsidies.                                                                                                                                                       | If incentives are thin, higher-income households adopt first; equity guardrails needed. |

**Housing Retrofits & Weatherization**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                          | Community Benefits                                                                    |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Weatherization yields 15–30% heating-fuel savings per treated home. If 40% of homes treated $\rightarrow \sim 3,550\text{--}7,100$ mtCO <sub>2</sub> e across residential ( $\approx 6\text{--}12\%$ ). Works synergistically with clean-heat. | Targets leakiest homes; reduces load before fuel switch.                              |
| Energy cost savings | High             | Bill reductions 15–30% (heating); comfort and safety increases.                                                                                                                                                                                | Biggest dollar relief for high-burden households.                                     |
| Health benefits     | High             | Warmer, drier, safer homes; fewer drafts/mold; fewer cold-stress events.                                                                                                                                                                       | Strong benefits for kids, elders, people with chronic disease.                        |
| Resilience          | High             | Tighter envelopes hold heat during outages; reduces peak demand.                                                                                                                                                                               | Improves shelter-in-place capacity for vulnerable residents.                          |
| Disbenefits/risks   | Low–Moderate     | Program cost, contractor capacity, potential rent increases if upgrades raise property values; ensure tenant protections.                                                                                                                      | Guard against displacement; prioritize deed-restricted/tribal housing where possible. |

**Electricity Generation Shift (Petroleum → Renewables / Hybrid Microgrids)**

| Outcome             | Potential Impact         | Quantitative / Qualitative Assessment                                                                                                 | Community Benefits                                                                   |
|---------------------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| GHG reduction       | Moderate                 | Local gen ≈18,941 mt. Displacing 30–50% of petroleum kWh with wind/solar + storage/hybrid → ~5,700–9,500 mtCO <sub>2</sub> e avoided. | Enables cleaner, more stable tariffs long-term.                                      |
| Energy cost savings | Moderate–High (long-run) | Capex heavy; OPEX lower vs. diesel. Levelized costs trend down with renewables; tariff stability improves.                            | Shields households from fuel volatility; benefits prepaid/low-income customers.      |
| Health benefits     | Moderate                 | Fewer generator emissions and fuel handling; quieter communities.                                                                     | Indirect but positive—especially near generation sites.                              |
| Resilience          | High                     | Storage + hybrid ops improve reliability; less dependence on fuel deliveries.                                                         | Outage reduction benefits medically vulnerable and households with limited backup.   |
| Disbenefits/risks   | Moderate                 | Intermittency, storage sizing, winter insolation; near-term rates can rise if capex not grant-funded.                                 | Without grants, cost shifts could burden vulnerable residents—need bill protections. |

**Transportation Improvements (Efficiency, Safety, Targeted Electrification & Shared Mobility)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                          | Community Benefits                                                                     |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Transport ≈32,152 mt. Freight/logistics efficiency + modest EV/low-carbon fuels achieve 10–20% sector cuts → ~3,200–6,400 mtCO <sub>2</sub> e. | Focus on shared/community vehicles and essential freight to reach at-risk populations. |
| Energy cost savings | Moderate         | Lower fuel use via routing/idle reduction; EVs lower OPEX where charging feasible; pooled services cut per-household costs.                    | Reduces high transport cost burden for households without reliable vehicles.           |
| Health benefits     | Moderate         | Safety investments reduce injuries/fatalities; lower tailpipe exposure.                                                                        | Disproportionate safety gains in underserved areas.                                    |
| Resilience          | Moderate         | More reliable access to services; diversified fuels.                                                                                           | Improves access to clinics, schools, jobs for those with limited mobility.             |
| Disbenefits/risks   | Low–Moderate     | High capital needs; sparse charging/fueling; risk of focusing on private EVs over community solutions.                                         | Equity requires prioritizing shared/essential services first.                          |

**Community Infrastructure & Access (Hubs, Digital Access, Program Enablement)**

| Outcome             | Potential Impact        | Quantitative / Qualitative Assessment                                                                               | Community Benefits                                                     |
|---------------------|-------------------------|---------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate (indirect) | Enabling action; can unlock 1–3% cross-sector gains by raising participation and persistence of savings.            | Determines who can access and sustain benefits.                        |
| Energy cost savings | Moderate (indirect)     | One-stop enrollment, on-bill assistance, device lending reduce barriers; improves take-up of high-savings programs. | Critical for households lacking internet or time to navigate programs. |
| Health benefits     | Moderate (indirect)     | Outreach + indoor environment education magnify retrofit/clean-heat impacts.                                        | Reaches hard-to-contact households; supports self-advocacy.            |
| Resilience          | High (indirect)         | Hubs provide warming/cooling, charging, communications during outages/extremes.                                     | First-line support for vulnerable residents.                           |
| Disbenefits/risks   | Low–Moderate            | If centralized, remote villages may be underserved; requires sustained staffing.                                    | Must design multi-hub/mobile models to avoid inequities.               |

**Cross-Cutting Community Benefits and Disbenefits**

Across all strategies, benefits for community benefits include:

- **Reduced cost burdens:** Most strategies (energy transition, housing retrofits, transportation improvements) directly lower household spending on fuel, power, and transport. This frees up income for essentials like food, health, and education.
- **Improved health outcomes:** Better indoor air quality, safer housing, and reduced pollution exposure support lower rates of respiratory illness, cardiovascular disease, and stress—key issues in the region.
- **Greater resilience:** Transitioning away from imported fuels and improving housing quality reduces vulnerability to extreme cold, fuel supply disruptions, and price shocks.
- **Enhanced access and opportunity:** Transportation upgrades, digital infrastructure, and stable electricity expand access to jobs, schools, healthcare, and civic participation.
- **Intergenerational benefits:** With nearly 40% of residents under 18, at-risk households with children stand to benefit most from safer housing, cleaner air, and lower living costs.

Potential disbenefits if not designed equitably:

- **High upfront costs:** Without strong subsidies and equitable program design, low-income households may be unable to participate in retrofits, clean transport, or renewable energy adoption.
- **Risk of uneven access:** Centralized infrastructure or programs may bypass the most remote villages, widening gaps in access to benefits.
- **Technical and workforce constraints:** Limited local capacity for installation and maintenance could delay benefits, and households in greatest need may face longer waits.
- **Short-term rate or cost increases:** Transition costs (e.g., new energy systems or renewable generation investments) could temporarily raise rates or housing costs, disproportionately impacting at-risk households if protections are not in place.
- **Potential displacement effects:** Housing upgrades could inadvertently raise property values and costs, creating affordability pressures if safeguards are not integrated.

## Path Forward

The analysis demonstrates that the most impactful strategies for the region lie in reducing dependence on petroleum fuels through energy transition and housing efficiency, while also addressing transportation access and community infrastructure gaps. Each of these approaches offers clear benefits for at-risk households—lowering cost burdens, improving health outcomes, and building resilience against environmental and economic shocks. At the same time, each strategy carries challenges, including high upfront costs, limited workforce capacity, and risks of uneven access, that must be addressed through targeted program design and investment.

The path forward requires coordinated action that layers mitigation with social benefit. In practical terms, this means:

- Prioritizing programs that deliver immediate cost savings (e.g., housing weatherization, energy efficiency upgrades) to build community trust and momentum.
- Expanding renewable generation and hybrid energy systems in ways that stabilize prices and reduce dependence on imported fuels.
- Improving transportation affordability and safety through community-scale solutions tailored to rural and remote conditions.
- Investing in digital and physical infrastructure that enables full participation by vulnerable communities in both planning and benefits.

By centering implementation on the needs of at-risk populations, the Lower Kuskokwim region can transform its sustainable energy roadmap into a broader framework for community resilience, health, and economic opportunity. This integrated approach positions the region to make meaningful contributions to the State's Sustainable Energy Action Plan, while ensuring that the transition to a cleaner energy future directly strengthens the well-being of its most vulnerable residents.



# Bethel, Bethel Census Area

Population: 6520  
Census Tract: 2050000200



Bethel, Alaska, is a regional hub for the Yukon-Kuskokwim Delta and reflects the compounded challenges of rural, remote communities in western Alaska. The community is heavily dependent on imported diesel fuel for electricity, heating, and transportation, which results in high costs, elevated criteria pollutants and greenhouse gas emissions, and persistent air quality concerns. Residents face socioeconomic vulnerabilities such as high poverty, high renter occupancy, and significant housing cost burdens. Health conditions—including elevated rates of asthma and diabetes—further increase community sensitivity to environmental stressors. For vulnerable and at-risk households, these challenges translate into high energy burdens, unsafe or unhealthy housing, and limited resilience during extreme weather or fuel disruptions.

In this context, emissions reduction strategies offer an opportunity to do more than reduce emissions—they can lower household costs, improve public health, and enhance community resilience. Evaluating the benefits and disbenefits of potential strategies provides a roadmap for identifying the most effective actions, ensuring that Bethel's transition to cleaner energy directly addresses the needs of its most vulnerable residents.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

- Transform Building Energy Use – Reduce reliance on fuel oils for heating and industrial needs by adopting cleaner energy sources and improving efficiency across homes and facilities.
- Decarbonize Local Power Supply – Expand renewable generation through microgrids and storage to cut diesel dependence, stabilize electricity costs, and strengthen resilience.
- Upgrade Housing Stock – Invest in weatherization, insulation, and efficient systems to lower energy demand, improve indoor air quality, and ease the burden on renters and families.

These not only address the city's largest emissions sources but also directly relieve financial and health burdens for the most vulnerable residents.



## Emissions Data Overview

Total modeled emissions: 89,918 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (82.35%)

- Residential sector: 31.53 % of total emissions
  - Residual Fuel Oil No. 5 (heavy oil): 25,368.13 mt CO<sub>2</sub>e (28.21 % of total)
  - Electricity (residence): 2,726.41 mt CO<sub>2</sub>e (3.03 %)
  - Propane: 250.05 mt CO<sub>2</sub>e (0.28 %)
  - Wood & wood residuals: 8.91 mt CO<sub>2</sub>e (a negligible share)
- Commercial sector: 16.34 % of total emissions
  - Distillate Fuel Oil No. 1: 5,823.79 mt CO<sub>2</sub>e (6.48 %)
  - Electricity (commercial): 8,406.02 mt CO<sub>2</sub>e (9.35 %)
  - Propane: 444.58 mt CO<sub>2</sub>e (0.49 %)
  - Wood & wood residuals: 16.16 mt CO<sub>2</sub>e (0.02 %)
- Industrial sector: 34.48 % of total emissions
  - Dominant fuel: distillate Fuel Oil No. 2: 31,001.89 mt CO<sub>2</sub>e (34.48 %)

### Transportation (17.65%)

- Fuel types:
  - Motor Gasoline: 11,964.71 mt CO<sub>2</sub>e (13.31 %)
  - Diesel Fuel: 3,907.16 mt CO<sub>2</sub>e (4.35 %)
  - Electricity (transport) ≈ 0.14 mt CO<sub>2</sub>e (negligible)
- Vehicle types (by emissions share):
  - Trucks (i.e. heavy, commercial, etc.) ≈ 15,007.73 mt CO<sub>2</sub>e (~ 94.55 % of transport emissions)
  - Passenger vehicles ≈ 839.36 mt CO<sub>2</sub>e (~ 5.29 %)
  - Motorcycles ≈ 24.91 mt CO<sub>2</sub>e (~ 0.16 %)

### Electricity Generation

- Total electricity use: ~ 40,265.36 MWh
- Fuel mix for generation:
  - Diesel generation: ~ 38,654.74 MWh → 11,132.57 mt CO<sub>2</sub>e (100 % of generation emissions)
  - Wind: ~ 1,207.96 MWh → no associated CO<sub>2</sub>e (i.e. 0 emissions from wind generation in this model)
- Note: Electricity-related emissions in this report are captured both under stationary combustion (for onsite generation) and in a combined “electricity generation” share.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Solid waste and wastewater emissions were not included in this dataset.

### Key Takeaways

- A very large share of emissions (over 80 %) stems from stationary sources — i.e. heating, industrial fuel use, commercial/residential facility operations. This means the heart of Bethel’s emissions challenge lies in how energy (especially heating and industrial fuels) is being sourced and used.
- Residual No. 5, distillate oils, and distillate No. 2 dominate the fuel mix across residential, commercial, and industrial sectors. Equivalent emissions from wood or other lower-carbon fuels are negligible in this snapshot.
- Nearly 18 % of emissions come from transportation, with the bulk of that from trucks (heavy vehicles). This suggests that freight, supply chains, and operations using heavy vehicles are key contributors in the region.
- Diesel-powered generation is the source of all modeled electricity emissions; wind plays a very small role by comparison. This implies the local grid is highly carbon-intensive.

## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather:** Bethel shows a 64.2 percentile risk for anticipated changes in extreme weather, highlighting high environmental vulnerability.
- **Disaster Losses:** Annualized disaster loss is valued at \$720,796, placing Bethel in the 38.6th percentile nationally.
- **Air Quality:** Diesel particulate matter exposure is measurable (0.01), and air toxics cancer risk is rated at 8.0.
- **Hazardous Sites:** Proximity to hazardous sites is above average (52.8 percentile), though there are no nearby Risk Management Plan facilities or Superfund sites.
- **Housing Stock:** Pre-1980s housing is relatively limited (19.3 percentile), but older structures are present.
- **Transportation/Airport:** No high-volume roads are nearby, but airport proximity is relatively high (37.5 percentile).

Implications: Bethel's environmental profile shows both exposure to extreme weather-driven risks and persistent pollution sources, particularly diesel and hazardous sites. Exposure to diesel particulate matter (PM) can cause serious health risks, including lung cancer, heart and respiratory diseases, and worsened asthma symptoms. This context underscores the importance of emissions reduction strategies that emphasize resilience and the reduction of localized pollution sources, especially diesel dependence.

### Public Health Indicators

- **Chronic Illness:** Asthma (5.6%) and diabetes (4.6%) rates place Bethel above the national midpoint, while high blood pressure affects 15.1% of residents.
- **Mental Health:** Poor mental health prevalence is notable at 7.8%, in the 61.9 percentile nationally.
- **Life Expectancy:** Average life expectancy is relatively high at 80.2 years, though low life expectancy ranks at the 32nd percentile, showing disparities within the community.
- **Cancer & Heart Disease:** Cancer prevalence (2.1%) and heart disease risk (43rd percentile) are moderate.

Implications: Bethel's population carries a significant burden of chronic and mental health conditions, leaving residents more vulnerable to pollution and environmental stressors. Substance abuse has also been noted as a significant concern for Bethel and the surrounding region. Pollution reduction efforts that improve air quality and energy systems could yield substantial health co-benefits.

### Socioeconomic Factors

- **Poverty & Employment:** Nearly 28% of residents live below 200% of the federal poverty line, unemployment is high (6.8%; 80.7 percentile), although Bethel has the lowest unemployment rate in the greater Bethel Census Area and income inequality is above the national midpoint (GINI 0.40).
- **Education:** 6.5% of adults lack a high school diploma, slightly above national averages.
- **Housing & Costs:** Renter occupancy is very high (63%; 90.9 percentile), with a housing cost burden affecting nearly one-quarter of households. Median home value is \$280,400, above the national average but difficult to access for many due to income constraints.
- **Insurance & Connectivity:** Uninsured rates are high (18.3%; 79.6 percentile), and 12.1% lack internet access.
- **Demographics:** Youth under 18 make up nearly one-third of the population (86.9 percentile nationally), while older adults are a smaller share (6.4%). Disability prevalence is modest (8.3%).

Implications: Socioeconomic vulnerabilities are pronounced, with high cost burdens, and limited insurance coverage shaping household stability. These pressures mean emissions reduction strategies must be designed to relieve economic burdens, not add to them.

### Transportation Insecurity

- **Access & Cost:** Transportation access scores are below average (40.5 percentile), while transportation costs as a share of household income are low (0.11), suggesting limited options but not extreme cost burdens.
- **Safety:** Traffic fatality rates are high (3.99 per 100,000; 74.4 percentile).
- **Geography:** Lack of road connections to other communities heightens reliance on air and river transport, reinforcing dependence on diesel fuels.

Implications: Transportation insecurity constrains mobility and makes the community highly dependent on fossil fuels. Emissions reduction in this sector must account for Bethel's geographic isolation and prioritize alternatives that fit remote conditions.

### Intersection with Emissions Reduction Planning

The conditions above shape the context for future decisions:

- **Economic Burden:** With high poverty, unemployment, and housing cost pressures, any pollution reduction strategy must deliver affordability, such as lower fuel bills or subsidized programs.
- **Health Vulnerability:** Elevated chronic disease mean health co-benefits of cleaner energy and air could be a major motivator.
- **Cultural/Community Priorities:** A young population and reliance on subsistence lifestyles make it critical to frame pollution reduction as protecting future generations and subsistence resources.
- **Geographic Barriers:** Isolation and diesel dependence make Bethel's situation unique; strategies must adapt to limited transportation and infrastructure.

## Mitigation Strategies

### Energy Transition and Stationary Combustion

The greatest opportunity for reducing emissions in Bethel lies in addressing stationary combustion, which accounts for more than 80 percent of the region's total emissions. Much of this comes from burning residual and distillate fuel oils for heating homes, powering commercial buildings, and fueling industrial operations. This dependence on expensive imported fuels not only drives criteria pollutants and greenhouse gas emissions but also places a heavy burden on households, especially given Bethel's high rates of poverty and housing cost burdens. By shifting toward cleaner, locally viable heating options and investing in efficiency upgrades, Bethel could significantly reduce emissions while easing the financial strain on families. For vulnerable populations, such measures would also reduce exposure to harmful indoor air pollutants, improving health outcomes in a community already struggling with high rates of asthma and diabetes.

### Cleaner Electricity Generation and Microgrid Development

Electricity generation in Bethel is nearly entirely powered by diesel, with only a small contribution from wind energy, and this sector alone accounts for more than 11 percent of total emissions. The reliance on imported diesel makes electricity costly and vulnerable to supply disruptions. Expanding renewable energy generation within a microgrid framework would reduce this dependency, stabilize energy costs, and improve resilience to extreme weather. Scaling up wind and solar-battery hybrids could provide a more reliable and cleaner local energy mix. These shifts would especially benefit vulnerable households, lowering electricity bills while also reducing air pollution from diesel generation, thereby improving respiratory and cardiovascular health in a population already facing chronic health challenges.

### Housing and Built Environment Improvements

Housing conditions in Bethel contribute directly to emissions as well as health risks. Overcrowding, high rental rates, and aging or substandard housing drive up heating demand and increase exposure to indoor air quality hazards. Weatherization, insulation upgrades, and replacement of inefficient heating systems would reduce energy use and emissions while improving the quality of life for residents. Because nearly

two-thirds of households are renter-occupied, strategies must consider landlord participation and potentially community-scale solutions rather than relying solely on individual ownership. For vulnerable households, better housing conditions would mean lower fuel bills, safer indoor environments, and reduced exposure to respiratory stressors, which could directly improve health outcomes in a community where chronic illness and poor mental health are already widespread.

### Transportation System Improvements

Although transportation accounts for a smaller share of emissions at roughly 18 percent, it remains an important area of focus due to Bethel's unique geography and reliance on freight transport. With no road connections to other communities, Bethel depends heavily on trucks, barges, and aircraft, with trucks alone contributing nearly all of the transportation-related emissions. Mitigation efforts in this sector could include optimizing freight logistics, adopting cleaner fuels for heavy-duty vehicles, and exploring opportunities to electrify local fleets. For residents, improved transit or shared mobility options could help reduce barriers to accessing education, healthcare, and employment. Lower freight emissions and greater efficiency in supply chains could also stabilize the high cost of goods and food, directly benefiting vulnerable households that experience high rates of poverty and food insecurity.

### Improved Outcomes for Overburdened and Underserved Communities

Mitigation strategies in Bethel must be understood as more than just environmental interventions; they are also pathways to better health outcomes. The community carries high rates of asthma, diabetes, and poor mental health, conditions that are worsened by exposure to pollution and inadequate housing. Reducing diesel combustion across heating, electricity, and transportation would directly improve air quality, lowering the prevalence and severity of respiratory and cardiovascular conditions. Coupled with housing improvements, these measures would create healthier living environments, particularly for vulnerable households with limited access to healthcare. By centering public health in sustainability planning, Bethel can frame pollution reduction not only as an environmental necessity but also as a way to improve daily life for its residents.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Energy Transition in Stationary Combustion (heating & industrial fuel use)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                          | Community Benefits                                                                                              |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Stationary combustion drives >80% of emissions; residential heating oils alone ≈28% of total. Displacing diesel/fuel oil has the largest mitigation potential. | Benefits households most burdened by high heating costs and inefficient homes.                                  |
| Energy cost savings | High             | Heating oil costs are very high due to transport; weatherization + efficient systems cut bills immediately.                                                    | Relief for families below 200% Federal Poverty Level (~28% of population) and renters with high energy burdens. |
| Health benefits     | Moderate–High    | Cleaner heating reduces indoor air pollutants; aligns with asthma (5.6%) and diabetes (4.6%) prevalence.                                                       | Strongest benefits for children, elders, and households in overcrowded housing.                                 |
| Resilience          | High             | Lower fuel demand eases dependence on shipments; weatherized homes safer during outages/extreme cold.                                                          | Provides security for at-risk families least able to afford backup systems.                                     |
| Disbenefits / risks | Low–Moderate     | Upfront retrofit costs, landlord/tenant split incentives, and workforce limits.                                                                                | Requires targeted programs so benefits reach renters and low-income families first.                             |

**Cleaner Electricity Generation & Microgrids (diesel displacement with renewables + storage)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                          | Community Benefits                                                                             |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Diesel supplies nearly all electricity; ~11% of total emissions tied to generation. Renewables + storage can cut this sharply. | Prioritizing diesel reduction directly helps households with high electricity bills.           |
| Energy cost savings | Moderate–High    | Long-term avoided diesel lowers utility costs; retail savings depend on rate design but can stabilize bills.                   | Critical for low-income households with high electricity burdens and no internet alternatives. |
| Health benefits     | Moderate         | Diesel plants add PM and noise; reducing generation cuts exposure in neighborhoods near plants.                                | Benefits at-risk households closest to diesel powerhouse sites.                                |
| Resilience          | High             | Storage and microgrids reduce outage risks from storms/fuel delays; strengthen reliability.                                    | Ensures continuous service for schools, clinics, and elder facilities.                         |
| Disbenefits / risks | Low–Moderate     | Capital costs, technical O&M challenges, intermittency without robust storage.                                                 | Equity guardrails needed to prevent higher rates for vulnerable households.                    |



**Housing & Built Environment Improvements (retrofits, weatherization, healthy homes)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                         | Community Benefits                                                                          |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Weatherization reduces heating demand, cutting fuel oil use tied to stationary combustion (28%+).             | Benefits concentrated in vulnerable households living in older/substandard units.           |
| Energy cost savings | High             | Direct, durable bill reductions from insulation and efficiency upgrades.                                      | Lower bills for renters (63% of households) and families facing housing cost burdens (24%). |
| Health benefits     | High             | Improves indoor air quality, reduces mold and overcrowding stress, addresses chronic disease vulnerabilities. | Direct health gains for families with asthma, poor mental health (7.8%), and other risks.   |
| Resilience          | High             | Better-insulated homes maintain livability in outages/extreme cold.                                           | Strongest protection for households with limited resources to adapt.                        |
| Disbenefits / risks | Moderate         | Barriers include landlord participation and upfront costs; workforce gaps for retrofits.                      | Must prioritize subsidies and programs tailored to vulnerable housing stock.                |

**Transportation System Improvements (freight, fleets, and local mobility)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                          | Community Benefits                                                              |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Transportation = ~18% of emissions; dominated by trucks and freight. Efficiency/logistics offer reductions but smaller than stationary/energy. | Freight efficiency can stabilize goods pricing for households.                  |
| Energy cost savings | Moderate         | Route optimization and fuel-switching lower freight diesel costs; could reduce cost of goods.                                                  | Benefits at-risk families through lower food and medicine costs.                |
| Health benefits     | Low–Moderate     | Reduced diesel near airport, barges, and community hubs improves localized air quality.                                                        | Helps workers, children, and elders near transport corridors.                   |
| Resilience          | Moderate         | Reduced fuel dependency and selective electrification strengthen supply reliability.                                                           | Ensures consistent access to essential goods for vulnerable residents.          |
| Disbenefits / risks | Low–Moderate     | Infrastructure limitations, high upfront vehicle costs, limited adoption.                                                                      | Without equity design, benefits may accrue to better-resourced operators first. |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy burdens – Cuts heating and electricity bills in a community where energy costs are among the highest in Alaska.
- Improved indoor environments – Weatherization and clean heating reduce mold, overcrowding stress, and indoor air pollution.
- Better respiratory and cardiovascular health – Less diesel combustion decreases exposure to PM and NO<sub>x</sub>, benefiting residents with asthma, diabetes, or heart disease.
- Stabilized access to essential goods – Freight efficiency and reliable local power systems improve affordability and availability of food, fuel, and medicine.
- Greater resilience to outages and extreme weather – Energy efficiency, renewables, and storage reduce dependence on fuel shipments and extend safety during disruptions.
- Job creation and workforce pathways – Local efficiency and clean energy projects can generate employment and training opportunities in vulnerable communities.
- Intergenerational equity – Protects children and youth (large share of population) by reducing exposure to environmental health risks and securing subsistence resources.

Potential disbenefits if not designed equitably:

- High upfront costs – Without subsidies, vulnerable households and small operators may not be able to participate.
- Landlord/tenant split incentives – Renters (a majority in some communities) may not see benefits unless landlords are included.
- Workforce and supply constraints – Limited local technical capacity may delay projects or increase costs, risking inequitable rollout.
- Technology mismatch risks – Equipment not suited to Arctic/maritime conditions (e.g., heat pumps, EVs) could fail, leading to wasted investment.
- Utility rate structures – If renewable investments increase system costs without proper design, low-income households could face higher bills.
- Equity gaps in program design – Without targeted funding or outreach, benefits may flow first to better-resourced households or businesses, leaving vulnerable communities behind.

### Path Forward

The analysis of Bethel's emissions profile and social determinants of health points clearly to three priority strategies: reducing stationary combustion through cleaner fuels and efficiency, transitioning electricity generation away from diesel toward renewables and microgrids, and improving the housing stock through weatherization and healthier home upgrades. Together, these strategies offer the largest reductions in criteria pollutants and greenhouse gas emissions while also providing the strongest benefits in cost savings, health improvements, and resilience. Transportation improvements, though a smaller share of overall emissions, remain important for stabilizing freight costs, improving food security, and reducing localized pollution. Health co-benefits—particularly for households with limited healthcare access—cut across all strategies and should be emphasized as central outcomes.

The path forward for Bethel should center on combining these strategies into layered solutions that reduce costs and pollution simultaneously. For example, weatherization and clean heating upgrades can be paired with renewable power investments to maximize efficiency gains. Equity mechanisms must be embedded throughout—such as subsidies for low-income households, renter-focused retrofit programs, and protections against regressive energy rates—to ensure that at-risk communities are prioritized. By aligning emissions reduction action with affordability, health, and resilience, Bethel can chart a course toward a cleaner and more secure energy.

# Upper Kuskokwim, Bethel Census Area

Population: 1,290  
 Census Tract: 2050000300  
 Communities: Aniak, Chuathbaluk, Crooked Creek, Lime Village, Red Devil, Sleetmute, Lower Kalskag, Stony River, Upper Kalskag

The Upper Kuskokwim region faces a unique set of challenges at the intersection of environmental health, and socioeconomic conditions. Households experience some of the highest energy burdens in the nation, paying a large share of their limited income on heating fuel and transportation. Public facilities that anchor community life—schools, clinics, and local government buildings—depend heavily on expensive fuels, while rural power systems rely on aging diesel engines that contribute both to greenhouse gas (GHG) emissions and harmful local air pollutants. These conditions are compounded by high poverty, unemployment, and health disparities, which place vulnerable households at particular risk.

Mitigation strategies for this region must therefore do more than reduce emissions: they must deliver direct and tangible benefits to residents, lowering daily costs, improving health outcomes, and strengthening resilience against extreme weather and supply disruptions. By focusing on the largest sources of emissions—home heating, public facilities, and local power generation—these strategies align sustainability goals with pressing community needs. The result is a pathway that not only advances the state’s Sustainable Energy Action Plan but also creates warmer homes, stronger community services, and a more stable future for those most burdened today.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Weatherization and Heating Upgrades
2. Public Facility Retrofits (schools, clinics, community buildings)
3. Rural Power System Upgrades

Together, these three strategies tackle the biggest emission sources (heating, public buildings, and power generation), directly lower household and community costs, which matter most in a high-poverty area, and improve health and resilience in a place where heart disease and energy insecurity are already big challenges.

## Emissions Data Overview

Note that the Bethel Census area consists of three Census Tracts. These emissions data are for the entire Census Area.

Total modeled emissions: ~152,523 metric tons CO<sub>2</sub>e.

### Stationary combustion (78.9% of total emissions)

- Residential sector: ~38.8% of total emissions.
  - Residual Fuel Oil No. 5 is dominant: ~51,912 mt CO<sub>2</sub>e (~34% of total emissions).
  - Electricity, natural gas, propane, wood/wood residues make up smaller shares.
- Commercial sector: ~19.8% of total.
  - Distillate Fuel Oil No. 1 large portion (~10.84%).
  - Electricity also significant (~8.1%) in that sector.
- Industrial sector: ~20.33% of total.
  - Distillate Fuel Oil No. 2 (~31,001.89 mt CO<sub>2</sub>e) is major.

### Transportation: (21.08% of total emissions)

- Motor gasoline (~15.89% of total) is the largest, then diesel fuel.
- Trucks are the main vehicle type contributing (~94.55% of the transport emissions).

### Electricity generation:

- Almost all electricity generation emissions come from petroleum sources. ~65,767 MWh generated from petroleum in community, producing ~18,940.98 mt CO<sub>2</sub>e.
- Wind is present but contributes negligible or zero associated emissions (i.e., probably intermittent or small scale).

### Other sectors (industrial process, waste & wastewater, agriculture & land-use)

- Not included in this report.

### Key Observations / Takeaways

- The majority of emissions come from stationary combustion — heating, power generation, industrial heating — rather than transport or electricity import.
- Among stationary sources, residual fuel oil (especially No. 5) in the residential sector, and distillate fuel oils in commercial/industrial, are big carbon contributors.
- Transportation contributes a nontrivial ~21%, heavily weighted toward heavy-duty trucks and gasoline.
- Electricity generation within the county is almost entirely fossil fuel (petroleum) driven.

## Social Determinants of Health

### Environmental Conditions

- Low industrial exposure: Diesel particulate matter, hazardous sites, toxic releases, and Superfund site proximity are all minimal or absent.
- Flood and extreme weather risk: There is a moderate anticipated change in extreme weather (12.5 percentile).
- Older housing stock: About 37% of homes were built pre-1980, at the 50th national percentile.

Implication: Pollution reduction efforts won't focus on cleaning up heavy industry but instead on localized energy use and heating fuels. Environmental adaptation may be more about weather reliability—important for subsistence activities and transportation. Older housing may have energy inefficiencies, meaning energy retrofits and weatherization are key for pollution reduction.

### Public Health Indicators

- Chronic disease burden: High rates of diabetes (59th percentile nationally), poor mental health (50th), and particularly heart disease (96th percentile) highlight systemic vulnerabilities.
- Life expectancy: Average life expectancy of 82 years is relatively strong, but the low life expectancy percentile (16th) signals disparities within the community.
- Respiratory and cancer rates: Asthma and cancer prevalence are mid-range nationally, suggesting no acute environmental health crisis from air pollution.

Implication: Emissions reduction strategies that improve indoor air quality and reduce reliance on diesel for heating may also improve health outcomes. Strategies will need equity-focused framing, as not all groups benefit equally from existing health protections. Pollution reduction could be framed as a long-term health and prevention rather than urgent crisis response.

### Socioeconomic Factors

- High poverty and disadvantage: 70.6% live under 200% Federal Poverty Level (FPL) (100th percentile), 23.7% lack a high school diploma (100th percentile), and unemployment is 13% (97th percentile).
- Energy burden: Households spend 9% of annual income on energy (99th percentile nationally).
- Housing conditions: Median home value is \$52,100 (2nd percentile), signaling low-cost but likely low-quality housing.
- Digital divide: Nearly 39% lack internet access (96th percentile).
- Demographics: Nearly 39% of the population is under 18 (98th percentile), while only 8% are over 65.

Implication: Any emissions reduction plan must address affordability, ensuring that energy transitions do not worsen financial strain. Reducing energy costs through efficiency and renewable alternatives may be the most direct way to align sustainability strategies with community needs. Investments in housing improvements could bring social and environmental benefits. Outreach must account for communication barriers, and framing around youth health and opportunity may resonate most strongly.

### Transportation Insecurity

- Limited access: Transportation access score is extremely low (0.01, ~43rd percentile).
- High costs: Households face very high transportation cost burden (97th percentile nationally).
- Safety concerns: Traffic fatalities are moderately high (63rd percentile).

Implication: Pollution reduction strategies requiring vehicle replacement or EV transition must address cost and access barriers to avoid deepening inequities. Safer and cleaner transportation solutions could provide dual benefits—reducing emissions and improving community safety.

### Intersection with Emissions Reduction Planning

The conditions above shape the context for future decisions:

- Equity is central: With high poverty, unemployment, and education gaps, emissions reduction solutions must reduce burdens rather than impose new ones.
- Energy efficiency is the highest leverage point: Extremely high energy burden and older housing stock make building retrofits and alternative heating sources key.
- Local infrastructure limits: Poor internet access and transportation insecurity mean outreach and implementation must be highly localized.
- Youth-centered framing: The unusually high proportion of children positions emissions reduction planning as an investment in future community health.
- Health co-benefits: Targeting air quality and energy systems has potential to directly address cardiovascular and metabolic health burdens.



## Mitigation Strategies

### Residential Weatherization and Heating System Upgrades

Improving housing efficiency through weatherization and upgraded heating systems offers some of the largest benefits for the Upper Kuskokwim region. Past Alaska programs demonstrate household energy savings of nearly 30% and reductions of 450 gallons of heating fuel per year, which translates into meaningful cost relief at rural prices exceeding \$6–\$7 per gallon. The emissions reductions are correspondingly high, as residential combustion is the largest source in the region’s inventory. For at-risk households—where more than half of residents live below 200% of the federal poverty line and energy burdens are among the highest nationally—this strategy directly addresses daily survival concerns. Health benefits are also high, as reduced indoor combustion lowers risks of asthma and cardiovascular disease, which are already elevated in the community. The risks are limited to program logistics and upfront costs, which must be managed through grants and no-cost participation for low-income households to avoid excluding those most in need.

### Public Facility Efficiency and Retrofits

Upgrading schools, clinics, and municipal facilities is another high-impact strategy. Modeled statewide, such improvements can eliminate over 60,000 metric tons of CO<sub>2</sub> annually by 2030, and similar proportional benefits could accrue in Upper Kuskokwim given the heavy fuel reliance of public buildings. For local governments, reduced operating costs free scarce resources for education, health care, and transportation services. These benefits are especially valuable to at-risk residents, who rely disproportionately on public institutions for support. The health improvements are moderate to high, with better indoor environments and lower exposure to local combustion byproducts, while resilience benefits are very strong—facilities can double as safe shelters during extreme weather events and remain operational during outages. The main disbenefit lies in the upfront capital requirements and challenges of mobilizing contractors to remote regions, but these can be addressed through targeted state and federal support tied to local-hire practices.

### Transportation Efficiency, Safety, and Community Mobility

Addressing transportation emissions in Upper Kuskokwim is more complex, but still offers meaningful benefits. Efficiency upgrades to trucks and gradual adoption of more fuel-efficient vehicles, combined with expanded community shuttle services, can reduce both fuel consumption and costs. State models suggest that new charging infrastructure can cut several hundred to a few thousand tons of CO<sub>2</sub> per site each year, but the feasibility and scale must be tailored to local use patterns. The health benefits here are particularly notable, as the region ranks in the 87th percentile nationally for traffic fatalities, making safety investments a life-saving intervention. Cost savings are also moderate to high, as families currently spend disproportionate amounts of income on transportation. The resilience benefits are moderate, improving access to clinics and schools in bad weather. Risks are mostly tied to infrastructure costs and the possibility of under-utilization, but pilot programs and phased expansion can mitigate these concerns.

### Rural Power System Upgrades (Engines, Distribution, Efficiency Programs)

Modernizing rural power systems through engine replacements, distribution upgrades, and efficiency programs like VEEP delivers a broad set of benefits. Documented projects in other Alaska villages show CO<sub>2</sub> reductions of around 7%, with even larger cuts to particulate matter (up to 93%) and nitrogen oxides (over 20%). These pollutant reductions carry significant health benefits in a community already facing high rates of heart disease and shortened life expectancy. Fuel savings from more efficient engines and reduced line losses also directly translate into lower costs for households and utilities, improving affordability in a tract already at the 99th percentile for energy burden. Resilience benefits are high, as reduced fuel dependence means fewer deliveries are required and systems are more stable during storms. Risks are relatively low, but include the need for skilled operators and ongoing maintenance, which underscores the importance of pairing infrastructure investment with workforce training.

### Improved Outcomes for Overburdened and Underserved Communities

For the vulnerable and at-risk households of Upper Kuskokwim, mitigation strategies are not abstract policy tools—they represent immediate opportunities to ease daily hardships. Housing upgrades and more efficient heating systems would lower the crushing energy burdens many families face, freeing up scarce income for food, healthcare, and education. In homes that currently leak heat and rely on heavy fuel oils, weatherization and heating system improvements can reduce exposure to combustion byproducts, improving respiratory and cardiovascular health outcomes for children and elders alike.

Improved transportation efficiency and safer community mobility options would likewise deliver direct benefits. For households that currently devote a large share of income to fuel costs, reducing dependence on high-consumption trucks or expanding access to affordable shuttles means more reliable access to essential services. Fewer transportation fatalities would also reduce the emotional and economic strain that accidents place on already fragile families.

The integration of local employment into mitigation projects further strengthens outcomes for vulnerable communities. By designing housing retrofits and infrastructure upgrades to be carried out by local workers, families gain not only immediate job opportunities but also skills that can support long-term stability. Youth, who make up a large share of the population, would see new pathways into meaningful work without leaving their communities.

Finally, strategies that reinforce clinics, schools, and community facilities ensure that at-risk households—often the least able to evacuate or adapt in times of crisis—are protected during extreme weather events. Energy-efficient community hubs can provide both reliable day-to-day services and emergency shelter, reducing vulnerabilities and giving families a sense of security. Taken together, these outcomes represent not just emissions reductions but a shift from persistent vulnerability toward greater stability, dignity, and opportunity for the region's most vulnerable residents.



Sleetmute: © Olivia Ebertz-KYUK

**Benefit (Disbenefit) Quantification or Qualitative Analysis****Residential weatherization & heating system upgrades**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                    | Community Benefits                                                                                                        |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Alaska's weatherization program has historically yielded ~30% CO <sub>2</sub> reduction per participating home (41,090 → 28,910 lbs/yr) and ~34% energy savings on average; savings-to-investment ~1.8 in the rebate program (and 1.5 for WAP lifecycle) | Directly lowers fuel use in homes with 99th-percentile energy burden locally; reduces reliance on costly deliveries.      |
| Energy cost savings | High             | Typical household fuel reduction ~453 gal/yr and ~29% bill savings in prior WAP results; rural winter heating fuel prices avg \$6.72–\$7.50/gal (2023), magnifying benefits.                                                                             | Greatest relief for low-income families (local <200% FPL = 54%) with high utility burdens.                                |
| Health benefits     | High             | Weatherization reduces moisture/mold and indoor combustion byproducts—improved respiratory/cardiovascular risks; aligns with local high heart-disease percentile (91st) and shorter life expectancy.                                                     |                                                                                                                           |
| Resilience          | High             | Fewer fuel deliveries needed; better winter habitability and less disruption during storms/freight delays.                                                                                                                                               | Prioritizing homes with highest burdens improves shelter-in-place resilience for elders/children prevalent in the region. |
| Disbenefits / risks | Low–Moderate     | Up-front costs, staffing/logistics in remote delivery; program throughput historically limited (200–300 homes/year statewide without new funding).                                                                                                       | Ensure no cost-shift to at-risk households; design grants/zero-cost participation to avoid exclusion.                     |

Lime Village: By Gholton at en.wikipedia, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=15801609>





### Public facilities (schools/clinics/municipal) efficiency & retrofits

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                       | Community Benefits                                                                                                                   |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Modeled statewide public-facility upgrades (~25% of buildings) → ~60,761 MT CO <sub>2</sub> e/yr by 2030; 1.46 MMT by 2050 (cumulative). Scale to regional facility count for localization. | Schools/clinics are critical lifelines in rural tracts; cuts in facility fuel use benefit every resident who relies on these spaces. |
| Energy cost savings | High             | Reduced fuel and O&M can improve fiscal flexibility for thin-revenue local governments; especially meaningful where heating oil is expensive and budgets are tight.                         | Savings can be redirected to services at-risk households use (education, health, transport).                                         |
| Health benefits     | Moderate–High    | Better IAQ/thermal comfort in schools and clinics; indirect air-quality gains from lower local combustion. (Fairbanks PM2.5 example illustrates co-benefits of fuel reductions.)            | At-risk residents disproportionately use public facilities; benefits are widely shared.                                              |
| Resilience          | High             | Efficient, reliable facilities function as community hubs/shelters in outages/extreme weather; less exposure to freight delays due to reduced fuel dependency.                              | Improves continuity of care and schooling—key for vulnerable families.                                                               |
| Disbenefits / risks | Low–Moderate     | Capital/match funding barriers cited statewide; logistics and contractor capacity in rural builds.                                                                                          | Targeted grants and local-hire requirements help ensure benefits accrue in-community.                                                |



**Transportation efficiency, safety, & community mobility (incl. strategic charging where practical)**

| Outcome             | Potential Impact   | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                      | Community Benefits                                                                                                        |
|---------------------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate (locally) | Efficiency upgrades, better routing, and gradual turnover of vehicles cut fuel use; where charging is sited, plan estimates ~536 tons CO <sub>2</sub> /yr per port and ~2,144 tons/yr per 4-port site (program-level anchor). Applicability depends on corridor access and utilization in Upper Kuskokwim. | Reduces fuel spend for households and fleets that face high transport burdens; must be tailored to local travel patterns. |
| Energy cost savings | Moderate–High      | Lower fuel consumption via efficiency and shared shuttles can ease 94.8th-percentile transport cost burden locally.                                                                                                                                                                                        | Improves access to clinics/schools/jobs for households with limited options.                                              |
| Health benefits     | High               | Traffic fatalities at 87th percentile → safety improvements (road fixes, shared services) yield meaningful health gains; reduced tailpipe exposure where trips are replaced/shortened.                                                                                                                     | Safety and access benefits accrue most to at-risk residents with fewer alternatives.                                      |
| Resilience          | Moderate           | More reliable, safer mobility reduces isolation during emergencies; supports freight coordination to minimize disruption.                                                                                                                                                                                  | Helps at-risk households reach essential services in bad weather.                                                         |
| Disbenefits / risks | Low–Moderate       | Capital costs for vehicles/infrastructure; cold-weather performance considerations; risk of under-utilization if sited without community input. Use phased pilots + data tracking (utilization-based scaling recommended in plan).                                                                         |                                                                                                                           |





### Rural power system upgrades (DERA engine replacements, distribution efficiency, VEEP)

| Outcome             | Potential Impact    | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                            | Community Benefits                                                               |
|---------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| GHG reduction       | Moderate            | Documented fuel and CO <sub>2</sub> reductions from diesel engine replacements (DERA) and line-loss cuts from distribution upgrades; example results include ~7% CO <sub>2</sub> plus large criteria-pollutant cuts in Akiachak; VEEP offsets ~1.19 GWh/yr across solicitations. | Benefits concentrate in remote, high-cost microgrids—typical of at-risk tracts.  |
| Energy cost savings | High                | Immediate fuel savings from certified engines and efficiency upgrades; lower losses reduce diesel burn and utility costs.                                                                                                                                                        | Helps stabilize bills for households with 99th-percentile energy burden locally. |
| Health benefits     | High (co-pollutant) | Large PM <sub>2.5</sub> (–93%) and NO <sub>x</sub> (–23%) reductions from engine replacements—important given cardiovascular risk profile in the tract.                                                                                                                          |                                                                                  |
| Resilience          | High                | Reduced diesel runtime and less frequent fuel deliveries increase reliability in storms and supply disruptions; modernization improves system stability.                                                                                                                         | Especially protective for households least able to absorb outages or delays.     |
| Disbenefits / risks | Low–Moderate        | Project delivery logistics; need for operator training and O&M support; dependence on external grant cycles (DERA/VEEP).                                                                                                                                                         |                                                                                  |



### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household costs – Reduced fuel and transport expenses ease extreme energy and cost burdens.
- Better health – Less indoor/outdoor combustion and safer roads improve respiratory, heart, and injury outcomes.
- Improved access – More reliable energy, transport, and facilities strengthen connections to schools, clinics, and services.
- Local jobs – Infrastructure upgrades create training and employment, keeping wages in the community.
- Youth opportunities – Stronger schools and workforce pathways benefit the region’s large youth population.
- Greater resilience – Fewer fuel deliveries and more reliable systems reduce vulnerability during storms or supply delays.
- Compounding benefits – Housing, transport, power, and facilities improvements reinforce one another for stronger overall outcomes.

### Potential disbenefits if not designed equitably:

- Upfront costs – Households may not afford contributions if programs don’t cover full expenses.
- Limited program capacity – Remote logistics and small contractor base can slow delivery.
- Technology reliability – New systems may fail without proper training or maintenance.
- Cold-weather performance – Equipment not suited to Arctic conditions may underperform.
- Funding trade-offs – Large projects could divert resources from other local priorities.
- Uneven access – Better-resourced households may benefit more if programs aren’t designed for equity.
- Information gaps – Lack of internet access may limit enrollment in assistance programs.
- Temporary disruption – Retrofits or facility work can interrupt daily life or services.
- Behavioral risks – Households may revert to higher fuel use if prices drop or habits persist.
- Community acceptance – Lack of local input may reduce adoption or trust in new systems.

### Path Forward

The Upper Kuskokwim region illustrates how emissions reduction and community well-being are deeply interconnected. By targeting the most significant sources of emissions—residential heating, public facilities, and rural power systems—the region can achieve meaningful emissions reductions while directly addressing the financial, health, and resilience challenges faced by its residents. These strategies are not abstract policy measures; they are practical steps that lower household costs, reduce health risks, and strengthen the community’s ability to withstand harsh weather and supply disruptions.

Moving forward, the priority should be to phase strategies in a way that maximizes both impact and feasibility. Weatherization and heating upgrades can begin quickly, bringing immediate relief to families struggling with high energy burdens. Public facility retrofits should follow, leveraging available funding to ensure schools and clinics can serve as resilient hubs. Finally, upgrading rural power systems provides long-term stability, reducing reliance on aging infrastructure and improving air quality across the region.

Success will depend on pairing these strategies with strong community engagement, local workforce development, and equitable program design that ensures at-risk households benefit first and most. By doing so, the Upper Kuskokwim region can transform its greatest vulnerabilities into opportunities for stability and resilience, while contributing to Alaska’s broader emissions reduction plan.

# Bristol Bay Borough

Population: 1,290  
 Census Tract: 2060000100  
 Communities: King Salmon, Naknek, South Naknek

King Salmon: © swamc.org

Bristol Bay Borough faces a dual challenge of addressing high criteria pollutants and greenhouse emissions while also contending with significant social and health disparities. The region's emissions profile shows an outsized reliance on petroleum fuels: nearly three-quarters of all emissions stem from transportation, dominated by freight trucks, while residual fuel oil for heating and petroleum-based electricity generation account for much of the remainder. At the same time, the borough's residents experience some of the highest national rates of asthma, diabetes, and high blood pressure, coupled with a severe household energy burden, older housing stock, and a high share of renters and seniors.

These overlapping conditions underscore the importance of emissions reduction strategies that do more than reduce emissions alone. Actions must also improve household affordability, strengthen resilience, and deliver health benefits—particularly for the vulnerable. Strategies that target both emission reductions and equity outcomes will be most effective, ensuring that Bristol Bay's transition to cleaner energy systems is inclusive, sustainable, and community-centered.

The following analysis identifies the most impactful mitigation strategies for Bristol Bay, focusing on areas where the largest emissions reductions intersect with the greatest potential benefits for health and equity.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Freight and Heating Fuel Transition
2. Building Weatherization and Energy Efficiency
3. Renewable Microgrids and Community Solar

Together, these measures deliver the greatest dual gains in emissions reduction and equity outcomes for the borough.

## Emissions Data Overview

Total Modeled Emissions: 42,092 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (25.45 %)

- Residential (10.49 % of total):
  - Electricity: 862.77 mt CO<sub>2</sub>e (~2.05 %)
  - Natural gas: 11.55 mt CO<sub>2</sub>e (~0.03 %)
  - Residual Fuel Oil No. 5: 3,537.39 mt CO<sub>2</sub>e (~8.40 %)
  - Wood & wood residuals: 2.49 mt CO<sub>2</sub>e (~0.01 %)
- Commercial (14.97 % of total):
  - Electricity: 5,373.47 mt CO<sub>2</sub>e (~12.77 %)
  - Distillate Fuel Oil No. 1: 858.35 mt CO<sub>2</sub>e (~2.04 %)
  - Propane: 65.53 mt CO<sub>2</sub>e (~0.16 %)
  - Wood / residuals: 2.38 mt CO<sub>2</sub>e (~0.01 %)
- Industrial: 0 % (no modeled contributions)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use):

- Not included in this dataset

### Transportation (74.55 %)

- Fuel breakdown:
  - Motor gasoline: 23,582.68 mt CO<sub>2</sub>e (~56.03 %)
  - Diesel fuel: 7,795.09 mt CO<sub>2</sub>e (~18.52 %)
  - Electricity: 0.20 mt CO<sub>2</sub>e (negligible)
- Vehicle types:
  - Trucks: 29,005.17 mt CO<sub>2</sub>e (~92.44 % of the transportation sector)
  - Passenger vehicles: 2,326.06 mt CO<sub>2</sub>e (~7.41 %)
  - Motorcycles: 46.74 mt CO<sub>2</sub>e (~0.15 %)

### Electricity Generation

- Total Electricity Consumption: 21,654.29 MWh.
- Petroleum: 21,654.29 MWh → 6,236.44 mt CO<sub>2</sub>e (100% of electricity generation emissions)
  - Residential demand: ~2% of total emissions (~863 mt).
  - Commercial demand: ~12.8% of total emissions (~5,373 mt).

### Key Takeaways

- Transportation dominates (¾ of total emissions), led by truck activity and heavy liquid fuel use.
- Electricity generation is the second critical pillar (12.9%), fueled entirely by petroleum, meaning every unit of consumption carries high emissions intensity.
- Stationary combustion overlaps with electricity use, but also reflects the reliance on residual fuel oil for heating.
- Other sectors are not modeled as contributors, suggesting focus should remain on energy and mobility.



## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather:** Anticipated changes are modest (2.27), but disaster loss percentile is relatively low nationally (7.39%). Still, local exposure to environmental disruptions remains possible.
- **Air Quality & Toxics:** Diesel PM exposure is negligible (0.00), though cancer risk from air toxics is moderately elevated (8.00 percentile). Toxic air releases sit at the 13th percentile, indicating limited exposure compared to the nation.
- **Hazardous Facilities:** Proximity to Risk Management Plan (RMP) facilities is high (78.41 percentile), suggesting potential vulnerability to accidental chemical releases. Other hazardous site exposures are low.
- **Housing & Infrastructure:** A notable proportion of homes were built before 1980 (43.6%, 64.20 percentile), which may mean older, less energy-efficient housing stock.
- **Transportation Infrastructure:** Proximity to high-volume roads is minimal, while airport proximity is moderate (34.09 percentile).

Implications: Environmental health exposures in Bristol Bay are moderate overall, but the high proportion of pre-1980 housing and RMP facility proximity raise concerns about resilience and safety. These factors suggest that emissions reduction strategies should be mindful of aging infrastructure and localized chemical risks, rather than roadway impacts

### Public Health Indicators

- **Chronic Illness:** Asthma (9.96%, 93.75 percentile), diabetes (9.77%, 94.32 percentile), and high blood pressure (31.83%, 93.75 percentile) are all alarmingly high relative to the nation. Cancer prevalence is also elevated (88.64 percentile).
- **Mental Health:** Poor mental health prevalence is above average (12.89%, 84.66 percentile).
- **Heart Disease:** At the national midpoint (51 percentile).
- **Life Expectancy:** Fair (79.9 years) but lower life expectancy measures rank at the 35th percentile.

Implications: Chronic disease burdens are strikingly high, which can limit residents' capacity to adapt to environmental changes. These health disparities underscore the importance of integrating pollution reduction efforts with public health initiatives to lessen stressors on vulnerable populations

### Socioeconomic Factors

- **Poverty & Employment:** Poverty is moderate (14.48%, 21.02 percentile) and unemployment is low (2.8%, 26.7 percentile). This suggests a relatively stable income base compared with other rural regions.
- **Education:** No high school diploma rates are average (6.2%, 50.57 percentile).
- **Housing & Costs:** Renter occupancy is high (48.6%, 77.84 percentile), but housing cost burden is very low (7.95 percentile). Median home value is modest (\$188,800).
- **Insurance & Digital Access:** Uninsured rates (16.1%, 68.75 percentile) and lack of internet access (19%, 72.16 percentile) are high, indicating barriers to health care and digital connectivity.
- **Energy & Utilities:** Energy burden is severe (5% of income, 92nd percentile).
- **Demographics:** High proportion of seniors (11.6%, 94.32 percentile) and elevated disability rates (15.9%, 75.57 percentile). Youth population is relatively low (19.3%, 23.86 percentile).
- **Housing Stock:** Pre-1960s housing is 10%, and mobile homes are present (4.8%, 68.75 percentile).

Implications: Socioeconomic challenges in Bristol Bay are concentrated in housing quality, digital inequity, and energy costs, compounded by an aging population. These conditions mean pollution reduction measures must carefully consider affordability, accessibility, and equity in design and implementation.



### Intersection with Emissions Reduction Planning

Bristol Bay Borough's social determinants of health highlight vulnerabilities that will shape how emissions reduction strategies are considered:

- **Health Burdens:** Elevated chronic illness rates will make health-centered pollution reductions more urgent.
- **Housing & Energy:** Old housing stock and high energy burden point to opportunities in energy efficiency retrofits and renewable transitions, but affordability is critical.
- **Socioeconomic Inequities:** High uninsured rates, digital gaps, and a large elderly population necessitate strategies that are accessible and adaptable for vulnerable groups.
- **Infrastructure & Transportation:** Limited road access, reliance on air transport, and exposure to RMP facilities mean strategies must be tailored to local infrastructure realities and safety concerns.

Overall, any emissions reduction approach in Bristol Bay must prioritize equity, affordability, and health resilience to be effective.

### Mitigation Strategies

#### Transportation Emissions Reduction

Transportation is by far the largest contributor to emissions in Bristol Bay Borough, responsible for nearly three-quarters of the total. Trucks dominate this category, reflecting the region's dependence on freight movement for goods and supplies. Gasoline and diesel fuel use are the central drivers, while electrification of vehicles is almost nonexistent. The social determinants of health add urgency here: asthma, cancer, and cardiovascular disease rates are all high, and exposure to air pollutants worsens these conditions.

Mitigation strategies in this sector will be most effective if they focus on the freight system first. Cleaner fuel switching for trucks and marine vessels, alongside improvements in freight efficiency and logistics, could substantially reduce emissions. Strategic electrification of smaller local fleets and passenger vehicles, supported by carefully placed charging infrastructure, would further cut pollution while offering health benefits to residents.

#### Stationary Energy and Heating Strategies

The second largest emissions source is stationary energy use, particularly from residual fuel oil burned for residential and commercial heating. Nearly half of the borough's housing stock predates 1980, making it less energy efficient, and the energy burden is among the highest in the nation. Seniors, renters, and households with disabilities face disproportionate challenges in meeting heating costs, which directly ties emissions reduction to economic and health resilience.

Effective mitigation strategies here will focus on reducing oil dependence. Weatherization programs, retrofitting older homes, and upgrading appliances would lower energy use while improving indoor comfort. Cold-climate heat pumps can replace oil heating and provide a cleaner, more stable energy source. In communities where many residents rent, policy and program design will need to ensure renters share in these improvements, not just property owners.

#### Electricity Generation Transition

Electricity generation accounts for about 13 percent of Bristol Bay's emissions and is fueled almost entirely by petroleum. This means that every kilowatt-hour consumed comes with a high emissions cost. The result is that electricity use in both homes and businesses compounds emissions from stationary energy.

Transitioning generation to renewable sources is therefore a powerful lever. Renewable microgrids that combine wind, solar, and storage can cut reliance on imported fuels and build resilience in a region with limited infrastructure. Community solar projects, particularly those structured with cooperative or subscription models, could extend benefits to renters and lower-income households, ensuring broader equity in the energy transition. By decarbonizing electricity supply, all efficiency measures and electrification initiatives become more effective in reducing emissions.

### Improved Outcomes for Overburdened and Underserved Communities

The social determinants of health in Bristol Bay underscore the importance of designing mitigation strategies with equity and health co-benefits in mind. Rates of chronic disease are high, uninsured populations are significant, and many households struggle with digital access or fixed incomes. Seniors, who make up a large share of the population, are especially vulnerable to both high energy costs and environmental impacts.

Strategies that improve indoor air quality, reduce energy bills, and strengthen local capacity will not only cut emissions but also improve health and economic resilience. Workforce training, expanded internet access, and community participation in clean energy projects can ensure that the transition creates opportunities rather than new divides. By centering equity, Bristol Bay can align emissions reduction action with better health outcomes and stronger community resilience.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

#### Transportation (freight efficiency, cleaner fuels, targeted electrification)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                                                                                      | Community Benefits                                                                                                                                                                                        |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Transport is ~74.55% of 42,092 mt → ~31–32k mtCO <sub>2</sub> e baseline. A combined package (freight efficiency + renewable/bio-diesel blend + limited EV uptake for light-duty and municipal) could plausibly cut 10–25% of transport in the near/medium term ⇒ ~3–8k mtCO <sub>2</sub> e/yr. Larger gains require deeper fuel switching and turnover of heavy vehicles. | Reduces pollution where people live/work; health co-benefits accrue to households with high chronic disease rates and seniors. Prioritize routes touching vulnerable areas and essential-goods corridors. |
| Energy cost savings | Moderate         | Freight efficiency (routing, consolidation) lowers fuel spend; renewable diesel may carry price premium but can be offset by fewer gallons used. Light-duty EVs shift costs to electricity (still petroleum-based today) but cut maintenance/fuel volatility. Net moderate savings at community scale.                                                                     | Savings can lower delivered-goods costs; pair with support for low-income households (e.g., EV charging where residents shop/work).                                                                       |
| Health benefits     | High             | Fewer diesel/gas miles and cleaner fuels reduce NO <sub>x</sub> /PM and toxics exposure—salient with asthma (93.75th pctile) and cancer prevalence concerns.                                                                                                                                                                                                               | Focus investments where asthma/elder risks and uninsured rates are high to reduce barriers to care & exposure.                                                                                            |
| Resilience          | Moderate         | Efficiency + some fuel diversification (e.g., renewable diesel where available) reduces exposure to supply shocks; limited road network constrains alternatives, but logistics upgrades help during disruptions.                                                                                                                                                           | Target essential services (clinics, utilities, food supply) first to enhance community continuity for vulnerable households.                                                                              |
| Disbenefits / risks | Low–Moderate     | Renewable fuels' availability/price risk; EV cold-weather range & charging siting; upfront capital for fleets/infrastructure. Manage via phased pilots and TCO support.                                                                                                                                                                                                    | Avoid cost-shifting to low-income renters; design rates/incentives to prevent regressive impacts.                                                                                                         |

**Stationary Energy & Heating (weatherization, retrofits, heat pumps)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                         | Community Benefits                                                                                 |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Stationary $\approx$ 25.45% of total $\rightarrow$ $\sim$ 10–11k mtCO <sub>2</sub> e. Targeted retrofit + oil-to-heat-pump conversions can trim 15–35% of stationary emissions over time $\Rightarrow$ $\sim$ 1.5–4k mtCO <sub>2</sub> e/yr (higher with deeper penetration). | Prioritize older homes (pre-1980), seniors, and disabled residents to maximize comfort & equity.   |
| Energy cost savings | High             | Energy burden at 92nd percentile; weatherization routinely cuts heating load 15–30%+; heat pumps lower delivered-fuel spend and reduce price volatility exposure. Expect high household savings, especially in oil-heated homes.                                              |                                                                                                    |
| Health benefits     | High             | Better indoor air quality (less oil combustion), warmer/drier homes, reduced hypertension/respiratory stressors—important with high asthma/diabetes/HTN rates.                                                                                                                |                                                                                                    |
| Resilience          | High             | Tightened envelopes + efficient heat provide longer safe temperatures during outages and lower fuel dependence; optional thermal storage or backup integrates well.                                                                                                           | Target medically vulnerable and elder households first; coordinate with weatherization assistance. |
| Disbenefits / risks | Low–Moderate     | Upfront costs; contractor capacity; split-incentives for renters ( $\sim$ 49%)—mitigate via incentives, on-bill financing, and landlord participation requirements.                                                                                                           |                                                                                                    |



**Electricity Generation (renewable microgrids, storage, community solar)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                   | Community Benefits                                                                                                 |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Electricity emissions $\approx$ 6,236 mtCO <sub>2</sub> e (all petroleum). Partial renewable penetration (e.g., 30–60% annual kWh) could abate $\sim$ 1.9–3.7k mtCO <sub>2</sub> e/yr; deeper renewables + storage push |                                                                                                                    |
| Energy cost savings | Moderate         | Renewables + storage reduce diesel runtime and fuel imports; capex is significant but TCO can improve with grants/PCE alignment; savings rise as fuel prices spike.                                                     |                                                                                                                    |
| Health benefits     | Moderate         | Less local generator exhaust & upstream fuel handling; downstream benefits multiply when paired with electrified heating/EVs.                                                                                           | Lower generation costs and cleaner supply can support low-income bill relief and enable equitable electrification. |
| Resilience          | High             | Hybrid microgrids with storage improve outage performance and reduce dependence on fuel deliveries; community solar can operate with critical-load support.                                                             | Design resilient critical facilities first (clinics, water, communications) to protect vulnerable residents.       |
| Disbenefits / risks | Low–Moderate     | Intermittency, storage lifecycle/replacement, O&M capability, winter insolation limits; mitigate via diesel-hybrid design and operator training.                                                                        | Ensure participation models (co-op/subscription) include renters and uninsured households.                         |

**Cross-Cutting Community Benefits and Disbenefits**

Across all strategies, benefits for community benefits include:

- Lower household energy burden through weatherization, efficiency, and bill assistance — critical with energy costs in the 92nd percentile.
- Improved health outcomes from reduced indoor/outdoor pollution, especially for residents with high asthma, diabetes, and hypertension rates.
- Better housing quality for older and rental homes, creating safer, more resilient living environments for seniors and disabled residents.
- Inclusive access to renewable power and electrification via community solar and cooperative models, ensuring renters and uninsured populations can benefit.
- Workforce development and training tied to clean energy, creating local jobs and building long-term capacity.
- Stronger resilience for medically vulnerable residents through programs that protect critical facilities and expand access to backup systems.

Potential disbenefits if not designed equitably:

- High upfront costs for clean energy and electrification measures may burden households or landlords if not subsidized.
- Equity gaps if programs favor property owners over renters or wealthier households.
- Complexity in program enrollment may exclude residents with limited digital access (19% without internet).
- Supply chain and reliability risks for renewable systems (e.g., storage replacement, winter performance issues).
- Risk of regressive impacts if utility rate structures or fuel-switching programs increase costs for low-income households.

### Path Forward

Bristol Bay Borough's emissions profile and social determinants of health reveal both pressing challenges and unique opportunities. Transportation and heating fuels remain the largest drivers of emissions, while high rates of chronic disease, elevated energy burdens, and an aging housing stock place additional strain on residents. Addressing these issues together provides a clear path to achieve meaningful green-house gas reductions while also improving health, affordability, and resilience for vulnerable communities.

The most impactful strategies for the borough will focus on:

- Transitioning freight and heating fuels to cleaner alternatives, reducing both emissions and exposure to harmful pollutants.
- Expanding weatherization and efficiency programs to lower energy use and costs, particularly for renters, seniors, and households facing high burdens.
- Investing in renewable microgrids and community solar, cutting petroleum reliance while improving resilience and expanding equitable access to clean power.

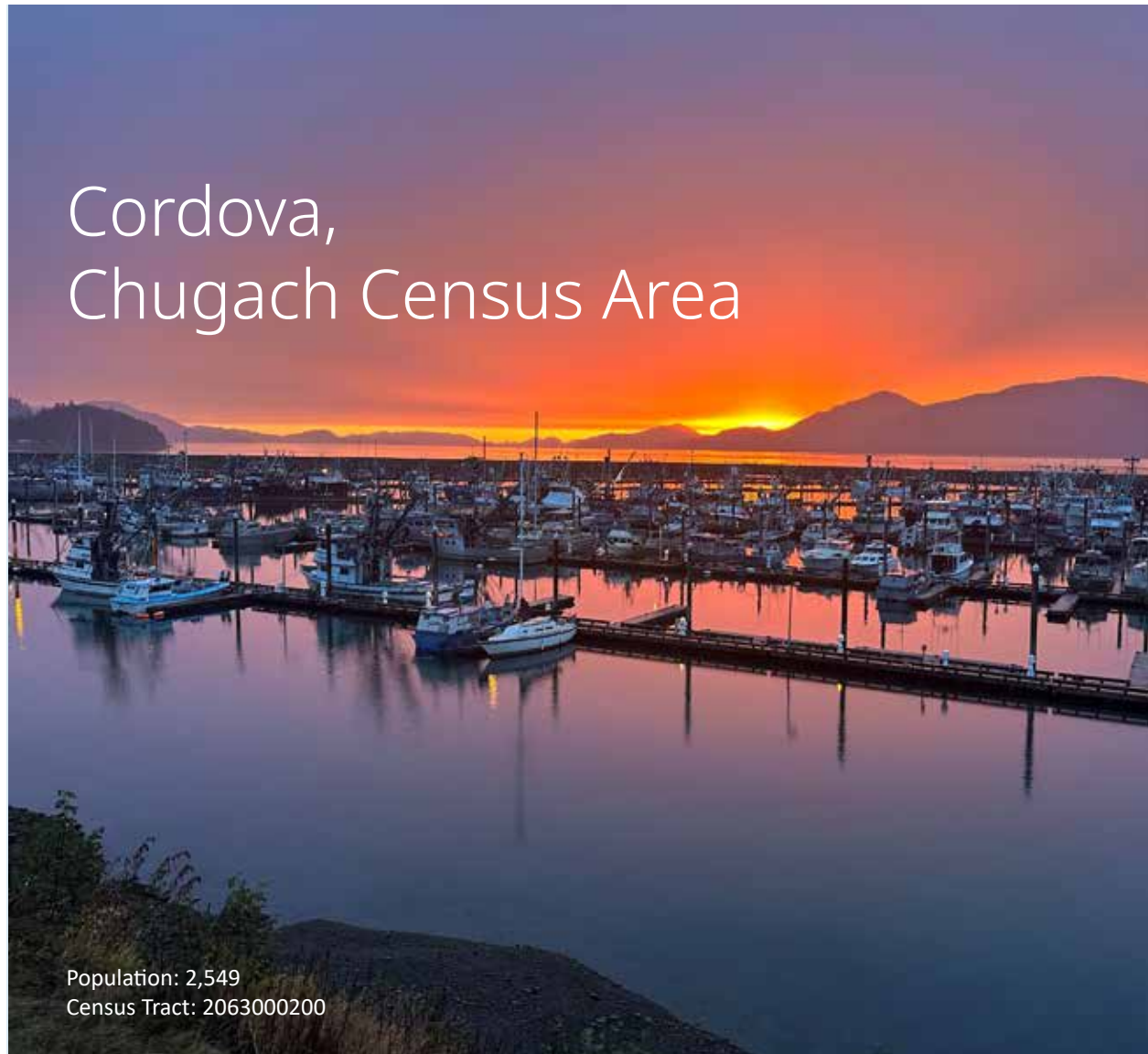
Moving forward, Bristol Bay can advance a phased approach that begins with “no regrets” measures such as efficiency upgrades, targeted pilot projects in freight and clean heating, and planning for renewable microgrids. Over time, these efforts can be scaled and integrated into the State's broader Sustainable Energy Action Plan, positioning Bristol Bay as a model for small, rural, and coastal communities facing similar challenges.

By aligning emissions reduction actions with health improvement and equity outcomes, Bristol Bay Borough has the opportunity not only to reduce emissions but also to build a more resilient, affordable, and healthy future for all its residents.



South Naknek: © swamc.org





Cordova, Alaska faces both challenges and opportunities as it works to reduce criteria pollutants and greenhouse gas (GHG) emissions while improving community well-being. The community's emissions profile shows a heavy dependence on fuel oil for residential and commercial heating, diesel for local electricity generation, and truck-based transportation for freight and mobility. These three areas together account for the vast majority of local emissions, making them critical priorities for action. At the same time, social determinants of health highlight both resilience strengths—such as relatively low poverty and high life expectancy—and vulnerabilities, including an aging housing stock, geographic isolation, and significant numbers of residents without health insurance.

Any roadmap for Cordova must therefore do more than cut emissions. It must also strengthen resilience, lower energy burdens, improve health outcomes, and create equitable benefits for at-risk communities. Strategies that reduce reliance on imported diesel and fuel oil, modernize and weatherize older homes, and expand access to clean, reliable power will deliver the greatest impact. These measures not only reduce emissions but also improve affordability and protect the health and safety of the community's most vulnerable residents. In this way, emissions reduction action in Cordova becomes an investment not just in environmental sustainability, but in equity, resilience, and long-term community vitality.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Building energy efficiency and fuel switching
  - a. Replacing fuel oil with weatherization and heat pumps tackles the largest emissions source (nearly half of total) while lowering household energy costs. At-risk residents benefit most from reduced fuel expenses, healthier indoor air, and protections against cold-weather vulnerability.
2. Clean and resilient power supply
  - a. Expanding hydro, solar, and storage to displace diesel generation eliminates over 10% of emissions and stabilizes local energy costs. This strengthens community resilience, particularly for clinics, schools, and shelters that at-risk households rely on during outages.
3. Transportation electrification and efficiency
  - o Targeting truck fleets, freight systems, and port/airport equipment addresses nearly a third of Cordova's emissions. Cleaner transport reduces diesel exposure for workers and neighborhoods, while equitable access to charging infrastructure expands mobility for vulnerable residents.

## Emissions Data Overview

Total Modeled Emissions: 17,420 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

Stationary Combustion (Buildings & Facilities) – 70.26% of total

- Residential sector (45.96%)
  - o Residual Fuel Oil No. 5: 7,394.7 mt (42.45%) → dominant single source of emissions.
  - o Electricity consumption: 451.9 mt (2.59%).
  - o Propane use: 142.9 mt (0.82%).
- Commercial sector (24.30%)
  - o Distillate Fuel Oil No. 1: 2,331 mt (13.38%).
  - o Electricity: 1,717.1 mt (9.86%).
  - o Propane and minor fuels add smaller shares.
- Key point: Building heating and energy use (especially heavy fuel oil) are the largest single source of emissions.

## Transportation – 29.74% of total

- Motor Gasoline: 3,064.4 mt (17.59%).
- Diesel Fuel: 2,116.6 mt (12.15%).
- Vehicle type breakdown:
  - o Trucks: ~82.9% of transport emissions.
  - o Passenger vehicles: ~16.6%.
- Key point: Heavy reliance on trucks for freight and travel drives nearly one-third of total emissions.

## Electricity Generation

- Diesel generators: 7,531 MWh → 2,169 mt CO<sub>2</sub>e.
- Hydro generation (18,357 MWh) provides zero direct emissions.
- Key point: Local electricity is split between hydro (clean) and diesel (polluting), with diesel responsible for all generation-related emissions.

## Industrial Processes – 0% of total

- No modeled emissions from chemical or industrial production.

## Other Sources of Emissions (Waste & Wastewater, Agriculture & Land Use) – 0% of total

- These emissions are not captured in this dataset; doesn't mean emissions are zero.

## Key Takeaways

Cordova's emissions are dominated by stationary combustion in homes and businesses (70%), followed by transportation (30%), with diesel-based electricity generation (11%) adding a significant burden. Heavy reliance on residual fuel oil and diesel are the critical drivers of carbon output.

## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Risk:** Anticipated changes in extreme weather rank moderately high (55.11), signaling vulnerability to environmental changes.
- **Disaster Losses:** Annualized disaster loss (\$458,888.31) is in the 27th percentile nationally, meaning lower than average exposure but still financially significant for a small community.
- **Air Quality:** Diesel PM exposure is 0.00, and toxic air releases rank very low (2nd percentile), indicating relatively clean air.
- **Toxic & Hazardous Sites:** Hazardous waste and Superfund site proximity are negligible (0–1 percentile). However, hazardous site proximity overall is at the 37th percentile, and risk management plan facility proximity is elevated (69th percentile).
- **Housing & Infrastructure:** A high share of pre-1980s housing (47.6%, 72nd percentile) raises concerns about outdated building materials and resilience to hazards.
- **Defense & Industrial Legacy:** The presence of formerly used defense sites may pose hidden contamination risks.

Implications: Cordova's relatively clean air and low toxic releases provide environmental strengths. However, aging housing stock and legacy defense sites create vulnerabilities. Extreme weather events could compound risks, especially where outdated infrastructure intersects with potential hazardous material exposure.

### Public Health Indicators

- **Chronic Illness:** Asthma (4.35%), diabetes (4.1%), and high blood pressure (15.6%) fall near national medians, while cancer prevalence (2.95%) is slightly above median (56th percentile).
- **Mental Health:** Poor mental health prevalence is modest (5.6%), below national averages (38th percentile).
- **Heart Disease:** Lower percentile ranking (31st) suggests relatively lower rates.
- **Life Expectancy:** At 81 years, the community surpasses the U.S. average, though its "low life expectancy" percentile score (25th) indicates disparities may exist within subgroups.

Implications: Overall health conditions are fairly strong, with above-average life expectancy and moderate prevalence of chronic disease. Yet, cancer and hypertension trends highlight potential stressors. These conditions may make residents more attentive to pollution exposure or health-related risks in emissions reduction planning.

### Socioeconomic Factors

- **Poverty & Inequality:** Only 10.3% of residents live under 200% of the poverty line (13th percentile), indicating relative financial stability. Income inequality is low (GINI 0.34, 11th percentile).
- **Education:** About 5.5% lack a high school diploma (41st percentile), suggesting decent educational attainment.
- **Employment:** Unemployment is exceptionally low (0.7%, 5th percentile).
- **Housing:** Median home value (\$330,200) is high (74th percentile), with 28% of units renter-occupied (47th percentile). Housing cost burden is very low (1st percentile), indicating affordability.
- **Insurance & Access:** A significant share of the population is uninsured (15.9%, 66th percentile).
- **Connectivity:** Limited internet access (5.4%, 20th percentile) may constrain education and healthcare access.

- **Demographics:** The population is aging (14% 65+), and 21% are youth, reflecting both ends of the age spectrum. Disability prevalence (8.6%) is moderate (20th percentile).
- **Housing Age:** Nearly one-fifth of homes predate 1960, compounding resilience challenges.
- **Mobile Homes:** At 6.8% (77th percentile nationally), mobile homes are a notable share, raising vulnerability to severe weather.

Implications: Cordova is relatively prosperous with affordable housing and low unemployment, but high uninsured rates and aging housing stock stand out as stress points. These conditions could intensify disparities when considering environmental health burdens or adaptation measures.

### Transportation Insecurity

- **Access:** Transportation access score is low (0.49), placing Cordova in the 81st percentile for insecurity, reflecting geographic isolation.
- **Cost Burden:** Transportation costs are minimal (0.11), suggesting affordability, but this may mask limited options.
- **Safety:** Traffic-related fatalities are absent (0%).

Implications: Cordova's geographic isolation and limited access to transportation infrastructure are significant barriers, especially for medical care, supply chains, and emergency response. While affordability is good, lack of mobility options may complicate participation in emissions reduction program.

### Intersection with Emissions Reduction Planning

Cordova's social determinants of health highlight both resilience assets and vulnerabilities that will shape how the community approaches emissions reduction:

- **Strengths to Leverage:** Low poverty, high life expectancy, and relatively clean air provide a foundation for community-driven initiatives that build on existing health and economic stability.
- **Challenges to Address:** Geographic isolation, aging housing, uninsured populations, and legacy contamination risks may increase the stakes of policy decisions. Vulnerable groups—seniors, renters, and residents in mobile or older homes—may require targeted protections.
- **Community Dynamics:** The balance between prosperity and pockets of vulnerability suggests that emissions reduction strategies will need to be equitable, ensuring that the uninsured and those in older housing do not bear disproportionate burdens.
- **Systemic Considerations:** Transportation limitations and reliance on older housing stock could affect feasibility of interventions (e.g., home energy retrofits, electrification). Health conditions like hypertension and cancer may also heighten sensitivity to pollution-related risks.



## Mitigation Strategies

### Building Energy Efficiency and Fuel Switching

In Cordova, the largest share of emissions comes from homes and businesses that still rely heavily on fuel oil for heat. Nearly half of the housing stock was built before 1980, meaning many buildings are poorly insulated and inefficient by today's standards. These older homes, combined with the high share of mobile housing, leave many residents vulnerable to cold weather and high fuel costs. Addressing these issues through weatherization, insulation upgrades, and a transition to clean heating systems such as electric heat pumps would have immediate benefits. Such changes would not only reduce carbon pollution but also cut household energy expenses and improve indoor air quality. Ensuring that renters, lower-income families, and older residents have access to these upgrades will be key to equitable implementation.

### Clean and Resilient Power Supply

Cordova benefits from an existing hydroelectric supply, which provides clean, zero-emission power to part of the community. However, diesel generators are still a significant part of the mix, responsible for over 11 percent of total emissions. Because the community is geographically isolated, reliance on imported diesel creates both environmental and economic risks, especially when fuel prices spike or shipments are delayed. Expanding renewable electricity—through increased hydro utilization, solar installations, and battery storage—would reduce this dependency and strengthen resilience. Investments in microgrids or hybrid systems could prioritize critical facilities such as clinics and schools, ensuring they can operate during disruptions. For an aging population, this resilience is as important as the emissions reduction itself.

### Health-Integrated Mitigation Approaches

Health data shows that while Cordova enjoys high life expectancy overall, rates of cancer and high blood pressure are above average. Reducing reliance on diesel and fuel oil would directly benefit public health by improving air quality, especially indoors where residents spend the most time during cold months. This is an opportunity to frame energy and emissions strategies not only as environmental policies but also as health interventions. By linking weatherization programs with improvements in ventilation and air filtration, Cordova can achieve dual benefits—cutting emissions and reducing health risks from respiratory and cardiovascular disease. Seniors, renters, and uninsured households should be prioritized so that the greatest health gains reach those most at risk.

### Waste and Circular Economy

Although emissions from waste were not included in the official inventory, opportunities still exist in this sector. Expanding recycling, composting, or biomass recovery could reduce indirect emissions while creating new forms of local employment. For a community with a relatively young population and limited economic diversification, developing circular economy initiatives could provide both environmental and social benefits. These efforts would also reduce reliance on diesel hauling of waste, aligning with broader transportation and emissions goals.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes for vulnerable residents in Cordova will flow directly from strategies that lower energy costs, reduce pollution exposure, and build resilience. Because residential fuel use accounts for the majority of local emissions, weatherization and electrification upgrades will have immediate and visible benefits for at-risk households. Energy burdens—while relatively modest in aggregate—fall hardest on renters, those in mobile or older homes, and uninsured residents. By pairing retrofits with equitable financial assistance and protections against rent increases, these programs can ensure that lower-income households enjoy the same reductions in heating costs and improvements in comfort as more affluent neighbors. Health outcomes will also improve: reduced indoor fuel combustion lowers the risk of respiratory and cardiovascular illness, directly benefitting seniors, children, and those with pre-existing conditions.



Beyond homes, investments in clean local power and resilient microgrids safeguard essential services such as clinics, schools, and emergency shelters—facilities that vulnerable residents often rely on most heavily during disruptions. Transportation improvements, including cleaner freight systems and equitable access to charging infrastructure, further reduce exposure to diesel pollution while expanding mobility options for those without reliable vehicles. Waste diversion and circular economy projects create local employment opportunities, especially valuable for young residents and those seeking stable work in a high-cost community. Finally, workforce training and public facility upgrades help ensure that the benefits of emissions reduction actions extend into economic opportunity, improved public services, and safer, healthier environments. Taken together, these strategies do more than cut emissions—they directly advance equity by closing gaps in affordability, health, and resilience for Cordova’s most vulnerable residents.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

#### Building Energy Efficiency & Fuel Switching (weatherization + heat pumps)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                | Community Benefits                                                                            |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Buildings drive most emissions; replacing fuel oil with efficiency and heat pumps targets the largest source. Statewide benchmarks show tens of thousands of tons avoided annually from weatherization and electrification programs. | Programs prioritize vulnerable households; equity guardrails are already in place.            |
| Energy cost savings | High             | Weatherization and electrification programs historically yield 30%+ household savings; hydro-supported heat pumps can cut heating costs by half.                                                                                     | Reduces energy burden for lower-income households; rebates and no-cost tiers increase access. |
| Health benefits     | High             | Reduced indoor combustion lowers soot and improves air quality; ventilation upgrades benefit cardiovascular and respiratory health.                                                                                                  | Seniors, renters, and older housing prioritized for greatest health gains.                    |
| Resilience          | Moderate–High    | Reduced fuel dependence lowers exposure to delivery disruptions; weatherized homes stay habitable longer during outages.                                                                                                             | Especially benefits households least able to evacuate or self-insure.                         |
| Disbenefits / risks | Low–Moderate     | Up-front costs, contractor capacity limits, and renter split incentives are barriers; grid impacts possible if electrification scales too fast.                                                                                      | Renters could face pass-through costs unless protections are included.                        |

**Clean & Resilient Power Supply (expand hydro, solar + storage, microgrids)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                        | Community Benefits                                                             |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| GHG reduction       | High             | Diesel generation contributes over 11% of total emissions; renewables with storage can eliminate most of it. | Reduces bills and improves local air for vulnerable areas.                     |
| Energy cost savings | Moderate–High    | Less diesel reduces exposure to volatile fuel costs; renewable projects can stabilize long-term rates.       | Households in energy assistance programs benefit from lower diesel dependence. |
| Health benefits     | Moderate         | Reduces criteria pollutants and noise from diesel plants; indirectly enables electrification of homes.       | Prioritize sites near residential and community facilities.                    |
| Resilience          | High             | Storage and hybrid systems reduce reliance on fuel delivery; critical facilities stay online during outages. | Directly benefits vulnerable residents reliant on local clinics and schools.   |
| Disbenefits / risks | Low–Moderate     | Capital intensive with long lead times; tariff design risks inequitable cost distribution.                   | Safeguards needed to prevent regressive rate impacts.                          |

**Transportation Efficiency & Fuel Alternatives (fleet electrification, logistics coordination, port/airport electrification)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                             | Community Benefits                                                           |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Transportation is 30% of emissions; truck freight dominates. Conversion of fleets and port equipment can yield steady but incremental reductions. | Cleaner freight operations reduce exposure for workers and nearby residents. |
| Energy cost savings | Moderate         | Electric vehicles and equipment can lower lifecycle costs; savings depend on duty cycle and power prices.                                         | Charging in vulnerable areas reduces barriers to adoption.                   |
| Health benefits     | Moderate         | Cutting diesel exhaust lowers exposure to fine particles and NOx, especially around ports.                                                        | Siting improvements near vulnerable communities maximizes benefit.           |
| Resilience          | Moderate         | Less fuel dependence improves security, but requires robust grid backup to be reliable.                                                           | Siting chargers at shelters and clinics supports equitable emergency access. |
| Disbenefits / risks | Low–Moderate     | High upfront costs, limited models for cold-weather freight, and under-utilization risks.                                                         | Avoid charger “deserts” and inequitable pricing structures.                  |

**Health-Integrated Mitigation (pair upgrades with IAQ and ventilation improvements)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                              | Community Benefits                                                                  |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Energy efficiency measures that improve ventilation indirectly cut fuel use.                                       | Targeting older, substandard housing amplifies both carbon and comfort benefits.    |
| Energy cost savings | Moderate–High    | Weatherization with balanced ventilation preserves efficiency and bill savings.                                    | No-cost tiers and program subsidies reduce energy burden for low-income households. |
| Health benefits     | High             | Strong evidence of improved respiratory and cardiovascular outcomes with reduced indoor combustion and better IAQ. | Advances health equity when focused on seniors, children, and renters.              |
| Resilience          | Moderate         | Well-ventilated and insulated homes stay safer during outages and smoke events.                                    | Benefits those least able to relocate in emergencies.                               |
| Disbenefits / risks | Low              | Risks of moisture or air-quality issues if retrofits poorly executed; mitigated through balanced ventilation.      | Avoid placing added maintenance burdens on low-income households.                   |

**Waste & Circular Economy (composting, diversion, biomass recovery)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                 | Community Benefits                                                              |
|---------------------|------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate     | Not modeled in inventory, but diversion reduces methane and diesel hauling emissions. | Job creation and reduced hauling costs benefit vulnerable households.           |
| Energy cost savings | Low–Moderate     | Savings from avoided landfill and hauling fees; compost can have market value.        | Lower fees can help low-income families directly.                               |
| Health benefits     | Low–Moderate     | Improved waste handling reduces odor and vectors; compost supports food security.     | Food and soil access benefit low-income households.                             |
| Resilience          | Moderate         | Local handling reduces vulnerability to transport disruptions.                        | Particularly beneficial for remote or vulnerable households.                    |
| Disbenefits / risks | Low              | Risk of odors or siting conflicts if not well managed.                                | Ensure facilities aren't placed disproportionately in low-income neighborhoods. |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy burden through weatherization, efficient heating, and renewable electricity.
- Improved indoor air quality and reduced exposure to fuel combustion, lowering risks for seniors, children, and those with chronic conditions.
- Enhanced community resilience from microgrids, storage, and weatherized homes, ensuring essential services during outages.
- Job creation and training opportunities in clean energy, building retrofits, and waste diversion programs, with pathways for vulnerable workers.
- Strengthened public facilities (schools, clinics, shelters) that directly serve at-risk residents.
- Transportation equity via reduced diesel exposure and better access to cleaner mobility options.

Potential disbenefits if not designed equitably:

- Upfront cost barriers if programs aren't structured with subsidies or no-cost tiers.
- Risk of displacement if landlords pass retrofit costs onto renters without protections.
- Tariff or rate increases if utility-scale projects are financed without equity safeguards.
- Uneven access if charging stations, retrofit programs, or waste facilities bypass vulnerable neighborhoods.
- Implementation strain in a tight labor market, which could limit timely delivery of benefits to at-risk households.

### Path Forward

Cordova's path toward reducing emissions is clear: focus first on the sources that matter most—residential fuel use, diesel power generation, and truck-dominated transportation. By prioritizing building weatherization and fuel switching, expanding clean and resilient local power, and electrifying key transportation systems, the community can achieve significant reductions in emissions while also lowering household costs, improving health outcomes, and strengthening resilience. These strategies have the added benefit of directly supporting low-income and vulnerable communities, ensuring that the transition is equitable and inclusive.

Moving forward, success will depend on pairing technical solutions with strong community engagement, workforce development, and financial support mechanisms that make upgrades accessible to all. Near-term efforts should emphasize programs with immediate and visible benefits, such as weatherization and efficiency upgrades, while medium- and long-term investments in renewable generation and transportation electrification can build lasting resilience and sustainability. By aligning local actions with the state-wide Sustainable Energy Action Plan, Cordova can leverage resources, share lessons, and ensure its efforts contribute to a broader transformation across Alaska. The result will be a community that is cleaner, healthier, and better prepared for the challenges and opportunities of a changing environment.







The Valdez/Western Prince William Sound region faces both opportunities and challenges as it considers strategies to reduce criteria pollutants and greenhouse gas (GHG) emissions and strengthen community well-being. Local emissions are dominated by stationary fuel use for heating and electricity, along with transportation from diesel and gasoline vehicles. At the same time, households experience high energy burdens, a large share of mobile and older housing, and limited transportation access. These conditions shape how mitigation strategies will affect residents, particularly vulnerable communities that are most sensitive to cost, health, and infrastructure changes.

The following analysis evaluates a set of priority strategies for their potential benefits and disbenefits, considering emissions reductions, cost savings, health outcomes, and resilience. Each strategy is assessed both qualitatively and, where possible, quantitatively, with explicit attention to how outcomes may vary across different segments of the community. This approach ensures that planning for emissions reduction is grounded in the realities of the region and aligned with the goal of improving overall quality of life while addressing the drivers of emissions.



## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Building & Housing Efficiency Retrofits
2. Low-Carbon Transportation Investments
3. Modern, Code-Ready Housing Replacement (Mobile Home Modernization)

The three strategies identified as most impactful—building and housing retrofits, low-carbon transportation investments, and modern, code-ready housing replacements—were selected because they directly address the region’s largest sources of criteria pollutants and greenhouse gas emissions while also delivering significant community benefits. Stationary fuel use in homes and buildings contributes the majority of local emissions, and households face some of the highest energy cost burdens; efficiency retrofits therefore provide both emissions reduction and affordability improvements. Transportation accounts for nearly as much of the emissions profile and exposes residents to elevated levels of air pollution and traffic safety risks, making clean mobility investments particularly important. Finally, replacing the oldest and least efficient mobile homes with modern, code-compliant, energy-efficient housing directly reduces heating demand, improves indoor air quality, and strengthens resilience in extreme winter conditions. In a community with a large share of mobile and older housing and high energy burdens, targeted housing replacement can deliver durable cost savings and healthier living conditions—especially where retrofits are not cost-effective or feasible.

## Emissions Data Overview

Note that the following data is for the entire 2010 Valdez-Cordova Census Area, which includes three 2020 Census Tracts (Cordova, Valdez/Western Prince William Sound, and Copper River).

Total Modeled Emissions: 155,891 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion Detail (53.39 %)

Breakdown by sector & fuel:

- Residential (~ 27.16 % of total emissions)
  - Electricity: 8,280.16 mt (~ 5.31 %)
  - Natural gas: 1,432.76 mt (~ 0.92 %)
  - Propane: 779.93 mt (~ 0.50 %)
  - Residual Fuel Oil No. 5: 31,638.50 mt (~ 20.3 %)
  - Wood & wood residuals: 204.56 mt (~ 0.13 %)
- Commercial (~ 12.37 % of total)
  - Distillate Fuel Oil No. 1: 8,869.32 mt (~ 5.69 %)
  - Natural gas: 491.84 mt (~ 0.32 %)
  - Propane: 677.08 mt (~ 0.43 %)
  - Electricity: 9,226.50 mt (~ 5.92 %)
  - Wood & residuals: 24.62 mt (~ 0.02 %)
- Industrial (~ 13.86 % of total)
  - Distillate Fuel Oil No. 2: 20,778.94 mt (~ 13.33 %)
  - Propane: 821.74 mt (~ 0.53 %)

### Transportation Detail (46.61 %)

- By fuel / vehicle type:
  - Diesel fuel: 29,686.10 mt (~ 19.04 %)
  - Motor gasoline: 42,977.99 mt (~ 27.57 %)
  - Electricity: 0.83 mt (negligible)

- By vehicle class:
  - Trucks: 60,255.11 mt ( $\approx 82.92\%$  of transportation emissions)
  - Passenger vehicles: 12,087.53 mt ( $\approx 16.63\%$ )
  - Motorcycles: 322.29 mt ( $\approx 0.44\%$ )

### Electricity Generation

- Total electricity used: 115,023.44 MWh
- Generation sources & emissions:
  - Hydro: 51,760.55 MWh  $\rightarrow$  0 mt CO<sub>2</sub>e
  - Petroleum (oil): 57,511.72 MWh  $\rightarrow$  16,563.37 mt CO<sub>2</sub>e ( $\approx 94.61\%$  of generation emissions)
  - Natural gas: 4,600.94 MWh  $\rightarrow$  944.11 mt CO<sub>2</sub>e ( $\approx 5.39\%$ )

Thus, petroleum-based generation is the primary driver of electricity emissions, despite hydro capacity.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Solid waste and wastewater emissions were not included in this dataset.

### Key Takeaways

- The emissions profile is dual-driven: although stationary combustion is slightly higher, transportation is nearly as large a share—meaning decarbonization efforts must address both buildings/fuel use *and* mobility.
- Heavy reliance on residual fuel oil and petroleum-based electricity generation points to fossil fuel dependency. Transitioning away from these would likely yield significant emissions reductions.
- The dominance of truck/diesel transport means freight, heavy vehicles, or infrastructure for commercial transport are critical leverage points.

## Social Determinants of Health

### Environmental Conditions

- Extreme Weather Risk: Anticipated changes in extreme weather (42.61 percentile) and disaster loss (\$836,231.59 annually) reflect moderate exposure to environment-related hazards.
- Pollution and Hazardous Sites: Diesel particulate matter exposure is reported at 0.00, but cancer risk from air toxics is elevated (8.00). Proximity to hazardous waste, toxic release, and RMP facilities places the community above average national percentiles in some risk categories (e.g., RMP facility proximity at 73.86).
- Infrastructure & Housing: Pre-1980s housing (50.36%) is high, suggesting vulnerability to outdated building standards. Formerly used defense sites add to environmental burdens. Road and airport proximities suggest moderate exposure to transit-related pollutants.

Implications: The community faces a mix of environmental strengths and risks. Older housing and proximity to hazardous facilities raise concerns for public health and resilience. These vulnerabilities underscore the need for careful integration of pollution reduction with legacy environmental burdens.

Implications: The community faces moderate disaster risk and infrastructure-related vulnerabilities. Legacy housing and industrial proximity raise both environmental health concerns and resilience challenges. These issues will interact with emissions reduction planning by making the community sensitive to disaster preparedness, industrial regulation, and safe housing retrofits.

### Public Health Indicators

- Chronic Conditions: Rates of asthma (3%), cancer (1.67%), high blood pressure (9.28%), and diabetes (2.24%) are all below national averages, placing them in lower percentiles. Mental health concerns (3.97%) are also low in the area, however, the City of Valdez has identified mental health services as a top priority for the past 6 years.
- Life Expectancy: At 82.9 years, life expectancy is strong compared to national norms, with relatively low prevalence of heart disease (14th percentile).

**Implications:** Overall health indicators are favorable, with chronic disease rates and mental health concerns well below national averages. This suggests resilience and a healthier-than-average population, though continued monitoring is warranted as environmental stressors increase.

### Socioeconomic Factors

- **Poverty and Education:** About 18.65% of residents live below 200% of the federal poverty line, with low unemployment (2.7%) and a relatively small share without a high school diploma (3.8%).
- **Housing and Costs:** Housing cost burden (21.02%) and median home value (\$160,600) are moderate. However, 26.25% of units are renter-occupied, and 22.2% are mobile homes—placing the tract at the 97th percentile nationally, highlighting structural vulnerability.
- **Access and Inequality:** Lack of internet access (16.3%) is relatively high, and uninsured rates (14.3%) exceed national norms. Energy burden is significant at 4% (78th percentile), suggesting high costs of heating and electricity. Income inequality is moderate (GINI 0.38).
- **Demographics:** Youth (21.5%) and seniors (13.2%) make up sizable portions of the population. Disability prevalence is moderate at 12.5%, and limited English proficiency is low (0.71%).

**Implications:** While economic stability is relatively strong, high energy burdens, uninsured rates, and reliance on mobile homes highlight structural and financial vulnerabilities. These factors may constrain the community's adaptive capacity in the face of environmental and pollution stresses.

### Transportation Insecurity

- **Access and Costs:** Transportation access is low (score of 0.38, 72nd percentile nationally), reflecting limited availability of mobility options. However, transportation cost burdens are modest at 0.11.
- **Safety:** Traffic fatality rates are high at 4.3 deaths per 100,000, placing the community in the 77th percentile.

**Implications:** Limited transportation access and elevated traffic fatalities signal mobility and safety challenges. These conditions may exacerbate inequities when considering transitions to low-carbon transportation or infrastructure investments.

### Intersection with Emissions Reduction Planning

The Valdez/Western Prince William Sound region shows a mix of strong health outcomes and economic stability, but also faces structural vulnerabilities in housing, energy costs, and transportation. These conditions will shape how the community can engage with and benefit from emissions reduction planning.

- **Housing and Energy Burdens:** A large share of mobile homes and older housing stock combine with high energy costs to make residents especially sensitive to changes in energy policy. Pollution reduction strategies must account for affordability and provide support for retrofits and efficiency upgrades.
- **Environmental and Health Risks:** While overall health outcomes are favorable, proximity to hazardous facilities and elevated air toxics risks highlight the need for clean energy solutions that reduce local emissions and avoid compounding legacy environmental burdens.
- **Economic and Access Barriers:** High uninsured rates, limited internet access, and reliance on rental housing point to barriers in accessing programs or incentives. Without targeted outreach and affordability protections, these groups could be excluded from the benefits of pollution reduction efforts.
- **Transportation and Safety Gaps:** Limited mobility options and higher-than-average traffic fatalities suggest that transitions to low-carbon transportation must integrate safety improvements and expanded access to ensure equitable outcomes.

Taken together, these factors suggest that emissions reduction planning in the region must go beyond emissions targets alone, embedding equity, affordability, and accessibility into its design so that benefits reach the most vulnerable households.

## Mitigation Strategies

### Building & Housing Efficiency Retrofits

The Valdez/Western Prince William Sound region has a disproportionately high share of mobile homes (22%) and older housing stock, with more than half of homes built before 1980. This makes building efficiency retrofits one of the most effective strategies. Investments in insulation, weatherization, and modern heating systems would not only cut emissions but also reduce the community's exceptionally high energy burden, which ranks in the 78th percentile nationally. Targeted support for low-income households is especially important to ensure equity. Because stationary combustion from heating oil and residual fuels accounts for more than half of the region's total emissions, housing retrofits offer a direct and impactful way to reduce both costs and carbon pollution.

### Modern, Code-Ready Housing Replacement (Mobile Home Modernization)

The Valdez/Western Prince William Sound region has an unusually high share of mobile homes (about 22%) and older housing stock, meaning some units are likely better candidates for replacement than incremental upgrades. A targeted housing replacement initiative—focused on phasing out the oldest mobile homes and replacing them with modern, energy-efficient homes designed for local conditions and current codes—would significantly cut heating fuel use, improve comfort, and reduce long-term household energy costs. Pairing replacement with strong affordability protections (to prevent displacement), streamlined permitting, and local workforce capacity building can ensure that modernization strengthens community stability while lowering emissions and improving health outcomes.

### Low-Carbon Transportation Investments

Transportation is responsible for nearly half of local emissions, with truck and diesel use dominating the sector. Reducing emissions here requires investments in electrification, such as transitioning municipal fleets and expanding charging infrastructure for residents. At the same time, improvements in road safety and public transport options are essential, as the region already ranks in the 77th percentile nationally for traffic fatalities and faces limited transportation access. By integrating safety upgrades with clean mobility initiatives, the region can both cut emissions and improve access for residents who currently face barriers to affordable and reliable transportation.

### Targeted Industrial & Port Decarbonization

Valdez's proximity to hazardous facilities and its role as a hub for port activity create unique challenges and opportunities for emissions reduction. Decarbonization strategies should focus on promoting cleaner marine fuels, electrifying port equipment, and addressing pollution from legacy defense and industrial sites. These measures would not only reduce industrial emissions but also improve local air quality, alleviating some of the cancer risk associated with air toxics exposure. By tackling these cumulative risks, the region can align industrial activity with emissions reduction objectives while protecting public health.

### Improved Outcomes for Overburdened and Underserved Communities

Residents of the Valdez/Western Prince William Sound area face challenges that include high energy costs, a significant share of mobile and older housing, and limited access to affordable transportation and health services. Implementing the recommended strategies can help improve living conditions and reduce household expenses in several ways. Building and housing upgrades can lower utility costs and make homes safer and more comfortable. Replacing the oldest mobile homes with modern, energy-efficient, code-ready housing can stabilize household energy costs while improving safety and comfort. Reducing emissions from industrial and port operations will further contribute to cleaner air and a healthier environment for nearby neighborhoods.

By focusing on affordability, accessibility, and broad participation in these programs, the region can ensure that energy and infrastructure improvements translate into direct benefits for residents. These actions will lower costs of living, improve public health, and enhance the overall quality of life while supporting a cleaner and more efficient local energy system.

**Benefit (Disbenefit) Quantification or Qualitative Analysis****Building & Housing Efficiency Retrofits**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                   | Community Benefits                                                                                                      |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Directly reduces heating fuel use in homes; addresses the stationary sector that represents over half of community emissions. Biggest effects from deep weatherization and heat-pump conversions in older/mobile homes. | High — Energy-burdened households and mobile homes mean outsized carbon and cost benefits when upgrades are subsidized. |
| Energy cost savings | High             | Envelope and HVAC retrofits typically cut a large share of fuel use; significant relief from volatile fuel prices.                                                                                                      | High — Largest relief accrues to low-income renters and homeowners who spend a higher share on energy.                  |
| Health benefits     | Moderate–High    | Improved indoor air quality, mold control, and thermal comfort; reduces cold-related stressors.                                                                                                                         | High — Greatest benefits for elders, disabled residents, and households in substandard units.                           |
| Resilience          | High             | Lower dependence on delivered fuels and tighter homes that maintain survivable temps during outages.                                                                                                                    | High — Most valuable for vulnerable households with limited backup options.                                             |
| Disbenefits / risks | Low–Moderate     | Upfront costs, contractor capacity, and split-incentives for renters.                                                                                                                                                   | Mitigation: prioritize no-cost participation, tenant protections, and contractor training.                              |

**Modern, Code-Ready Housing Replacement (Mobile Home Modernization)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                 | Community Benefits                                                                                                                            |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Replaces the least efficient housing units (often older mobile homes) with high-performance, code-compliant homes, reducing heating demand and delivered fuel use over the long term. | High — Largest benefits accrue to households living in the most energy-wasteful and uncomfortable units; durable reductions in energy burden. |
| Energy cost savings | High             | New construction standards (tight envelope, ventilation, efficient heating) can substantially reduce monthly heating costs and improve bill predictability.                           | High — Protects cost-burdened households from volatile heating fuel costs when affordability is preserved.                                    |
| Health benefits     | High             | Improves indoor air quality, moisture control, ventilation, and thermal comfort; reduces mold risk and cold-related stressors.                                                        | Greatest benefits for elders, people with disabilities, and households currently in substandard units.                                        |



## APPENDIX C: REGIONAL SUSTAINABLE ENERGY ROADMAPS

|                     |          |                                                                                                                                         |                                                                                                                                                  |
|---------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Resilience          | High     | Code-ready homes maintain safer indoor temperatures during outages and extreme cold; improves structural safety and weather resistance. | High — Particularly valuable for vulnerable households with limited backup heating options.                                                      |
| Disbenefits / risks | Moderate | High upfront costs; temporary relocation needs; risk of displacement or rent increases if not designed carefully.                       | Mitigation: Phase replacements, provide relocation assistance, ensure long-term affordability protections, and expand local contractor capacity. |

### Low-Carbon Transportation Investments

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                              | Community Benefits                                                                                                       |
|---------------------|------------------|----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Tackles nearly half of emissions; trucks and diesel dominate.                                      | High — Prioritizing cleaner fleets reduces diesel exposure in vulnerable areas.                                          |
| Energy cost savings | Moderate–High    | Fleet electrification lowers total cost of ownership; household savings depend on charging access. | Moderate–High — Lower fueling and maintenance costs help cost-burdened drivers if equitable charging access is provided. |
| Health benefits     | High (localized) | Cuts particulate and NOx emissions near roadways; safety improvements add co-benefits.             | High — Vulnerable residents often live near traffic corridors and face greater health risks.                             |
| Resilience          | Moderate         | Reduces reliance on imported fuels; vehicle-to-grid potential supports critical loads.             | Moderate–High — Public charging at hubs increases access for renters and those without home charging.                    |
| Disbenefits / risks | Moderate         | Upfront vehicle costs, charging gaps, and winter range limitations.                                | Mitigation: incentives for used EVs, public charging in underserved areas, and bundled safety upgrades.                  |

### Targeted Industrial & Port Decarbonization

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                         | Community Benefits                                                                        |
|---------------------|------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Shore power, clean marine fuels, and port electrification can significantly cut emissions.    | High — Reduces concentrated emissions where vulnerable residents live nearby.             |
| Energy cost savings | Moderate         | Savings vary by tariffs and capital support; long-term O&M savings for electrified equipment. | Moderate — Rate design should avoid shifting costs onto low-income households.            |
| Health benefits     | High (localized) | Substantial reductions in particulate matter and toxic exposures in port-adjacent areas.      | High — Delivers disproportionate air-quality benefits to vulnerable neighborhoods.        |
| Resilience          | Moderate–High    | Electrified equipment reduces spill/fire risks and improves continuity of port operations.    | Moderate–High — Safer, more reliable operations reduce risks to nearby homes and schools. |
| Disbenefits / risks | Low–Moderate     | Capital intensity and potential construction impacts.                                         | Mitigation: phased rollout, cost-sharing, and community benefit agreements.               |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household costs through reduced energy bills and transportation expenses.
- Improved housing quality with safer, healthier, and more comfortable living conditions.
- Cleaner air and environment from reductions in diesel, heating oil, and industrial emissions.
- Greater reliability and resilience during power outages, storms, or supply disruptions.
- Enhanced mobility and safety through expanded clean transportation and road safety improvements.

Potential disbenefits if not designed equitably:

- Upfront costs and affordability barriers if programs are not structured with subsidies or protections.
- Risk of exclusion if outreach does not reach households lacking internet access or insurance coverage.
- Disruption during construction or retrofits that could temporarily burden vulnerable residents.
- Cost-shifting concerns if large infrastructure investments raise rates or rents without safeguards.

### Path Forward

The analysis highlights that the most effective strategies for Valdez/Western Prince William Sound are those that both reduce emissions at scale and address the community's underlying challenges of energy burden, housing quality, and transportation access. Building and housing retrofits, low-carbon transportation investments, and modern, code-ready housing replacement stand out as the strategies with the highest potential to deliver meaningful benefits across environmental, cost, health, and resilience dimensions. Targeted industrial and port decarbonization also offers important localized gains in air quality and safety for nearby residents.

Moving forward, successful implementation will depend on ensuring that programs are designed to be accessible, affordable, and responsive to community needs. This includes prioritizing support for households with high energy costs, providing reliable alternatives to diesel transportation, and securing resources to modernize local energy systems. Careful planning will also be needed to mitigate potential risks such as construction disruptions, cost-shifting, or uneven access to benefits. By embedding these considerations into the design of future policies and investments, the region can build a roadmap that not only reduces emissions but also strengthens long-term community well-being.



# City and Borough of Juneau

Population: 31,436

Census Tracts: 2110000100, 2110000200, 2110000300, 2110000400, 2110000500, 2110000600

The City and Borough of Juneau (CBJ) faces a distinctive environmental and health context: community emissions are driven primarily by heating fuels in buildings and by gasoline in transportation, while electricity is supplied almost entirely by hydropower. This roadmap translates those facts into practical direction for near-term mitigation, with explicit attention to improved outcomes for vulnerable communities. It integrates a multi-tract view of social determinants of health (SDOH)—capturing differences among Downtown/Thane, Lemon Creek, the Mendenhall Valley, Douglas, and Auke Bay—with a community-scale emissions profile for 2022. The goal is to identify actions that meaningfully reduce criteria pollutants and greenhouse gas (GHG) emissions and deliver tangible co-benefits where residents live, learn, and work.

Our approach blends quantitative indicators (sector and fuel shares of emissions; prevalence of older housing; indicators of health burden; transportation access) with qualitative insights about housing tenure, flood exposure, and access barriers. We summarize conditions, then prioritize strategies that leverage Juneau’s zero-carbon electricity and address the largest sources first. Throughout, we reference improved outcomes for at-risk communities—lower energy burden, healthier indoor air, safer and more reliable services, and better mobility access—and flag potential disbenefits to manage (e.g., split incentives in rental housing or siting challenges for charging). The result is a focused set of actions that can be sequenced and scaled, aligning local implementation with the State’s Sustainable Energy Action Plan while remaining grounded in community realities.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Weatherize, then electrify homes (oil → cold-climate heat pumps)
2. Public-facility retrofits & strategic electrification (schools, clinics, water/wastewater)
3. Targeted EVSE build-out for community fleets and renters (with safety/access fixes)

Juneau's most impactful path combines building and mobility actions that align with its hydro-powered grid and risk-informed needs. First, weatherize, then electrify homes (oil to cold-climate heat pumps) to cut the community's largest emissions source while lowering energy burden, improving indoor air, and boosting winter safety—especially in older, renter, and mobile-home housing. Second, retrofit and strategically electrify public facilities—schools, clinics, and water/wastewater—to deliver reliable, visible reductions where at-risk residents rely on services, improving air quality, comfort, and continuity during cold snaps. Third, deploy targeted EV charging for fleets and renters to accelerate gasoline displacement, reduce per-mile travel costs, and shrink corridor pollution by siting chargers at multifamily housing, schools/clinics, and worker lots. Together, these moves deliver outsized emissions reductions and near-term, tangible co-benefits in the neighborhoods that need them most.

## Emissions Data Overview

Total Modeled Emissions: 247,763 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (71.84%)

- Residential Sector (41.64%)
  - Residual Fuel Oil No. 5: 92,777.23 mt CO<sub>2</sub>e (37.45% of community).
  - Natural gas: 7,082.92 mt CO<sub>2</sub>e (2.86%).
  - Propane: 3,167.34 mt CO<sub>2</sub>e (1.28%).
  - Wood & wood residuals: 131.51 mt CO<sub>2</sub>e (0.05%).
- Commercial Sector (12.81%)
  - Distillate Fuel Oil No. 1: 29,402.00 mt CO<sub>2</sub>e (11.87%).
  - Propane: 2,244.53 mt CO<sub>2</sub>e (0.91%).
  - Wood & wood residuals: 81.60 mt CO<sub>2</sub>e (0.03%).
- Industrial Sector (17.40%)
  - Distillate Fuel Oil No. 2: 42,890.03 mt CO<sub>2</sub>e (17.31%).
  - Used oil: 227.63 mt CO<sub>2</sub>e (0.09%).

### Transportation (28.16%)

By fuel type:

- Motor gasoline: 57,946.14 mt CO<sub>2</sub>e (23.39% of community).
- Diesel fuel: 11,812.10 mt CO<sub>2</sub>e (4.77%).

By vehicle type (within transport):

- Trucks: 58,284.31 mt CO<sub>2</sub>e (83.55% of transport emissions)
- Passenger vehicles: 11,393.46 mt CO<sub>2</sub>e (16.33%)
- Motorcycles: 80.46 mt CO<sub>2</sub>e (0.12%)

### Electricity Generation

- Electricity consumption: 405,176.46 MWh
- Generation sources:
  - Hydro: 405,176.46 → 0 mt CO<sub>2</sub>e

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.



## Key Takeaways

- Emissions profile: Community emissions in 2022 are concentrated in stationary combustion (~72%) and transportation (~28%), with electricity effectively zero-carbon due to hydroelectric supply.
- Dominant fuel: Residential No. 5 fuel oil is the single largest contributor, accounting for approximately 37% of total emissions.
- Transport fuels: Motor gasoline contributes ~23% of total emissions, with diesel adding an additional ~5%.
- Industrial mix: The industrial sector (~17%) is driven primarily by distillate fuel oil No. 2.
- Commercial sector: Commercial uses (~13%) are led by distillate fuel oil No. 1, with supplementary contributions from propane.
- Minor gaseous fuels: Natural gas and propane represent a comparatively small share of emissions in both residential and commercial contexts.
- Electricity implications: With ~405,000 MWh of hydroelectricity and negligible associated CO<sub>2</sub>e, electrification of end uses does not increase scope-2 emissions.
- Concentration of sources: A limited set of fuels—residential No. 5 oil, industrial No. 2 oil, and motor gasoline—accounts for the majority of emissions, indicating clear focal areas for subsequent planning.
- Sectoral distribution: Emissions are distributed across residential (~42%), industrial (~17%), commercial (~13%), and transportation (~28%), which provides a foundation for prioritizing engagement and program design.
- Operational timing: Given the fuel mix, emissions are likely seasonally concentrated during colder months and within oil-reliant facilities, a consideration for phasing and delivery in future planning.

## Social Determinants of Health

### Environmental & built environment

- Environmental hazards: Anticipated changes in extreme weather span ~20–70 (lowest Douglas; highest Auke Bay). Flood risk is a major differentiator: the share of local properties with flood risk ranges ~10–33%, peaking in West Mendenhall (33%; nat'l pct ~92), with other tracts commonly in the mid-to-high 20s. Annualized disaster loss in dollars varies from ~\$308k to ~\$816k across tracts; percentiles generally mid-range.
- Air & toxics: Diesel PM exposure is low-to-moderate but varies (~0.01–0.09), highest in Douglas; air toxics cancer risk is reported ~9–10 across tracts. Toxic releases to air percentiles are modest to mid (teens–50th), highest in Downtown/Thane (50th). Hazardous sites proximity is notably higher in Lemon Creek (5.43 tracts; 56th percentile) and low elsewhere.
- Legacy housing & infrastructure: Pre-1980s housing ranges widely (roughly 40–87% of occupied units), with Downtown/Thane extremely old housing (~86.5%; pre-1960s ~55%). High-volume road proximity and airport proximity differ strongly: East Mendenhall/Airport has high proximity to both (roads ~18.6%, airport ~63%), while Auke Bay and Downtown are much lower on those measures.

### Health status

- Chronic disease & mental health:
  - Asthma prevalence runs ~3.1–9.1% (higher in West Mendenhall and Auke Bay; lower in Douglas).
  - Diabetes ~2.4–6.8% and high blood pressure ~9.4–27.5%, with Auke Bay at the upper end for BP and Douglas/East Mendenhall at the lower end.
  - Poor mental health prevalence ~4.0–12.1%, higher in West Mendenhall.
  - Cancer prevalence ~1.8–6.0% (higher in Auke Bay).
- Longevity: Average life expectancy ranges ~72.4–86.0 years—Lemon Creek is the outlier low (~72.4; low-LE percentile ~92), while Douglas and East Mendenhall are very high (mid-80s). This gap signals meaningful neighborhood health and longevity disparities within CBJ.



### Socioeconomic context

- Economic security: <200% Federal Poverty Level (FPL) ranges ~5.7–29.1% (lowest East Mendenhall; highest Lemon Creek). Unemployment varies ~0.6–6.5%, higher in West Mendenhall. GINI ranges ~0.33–0.48, with Downtown/Thane showing the highest inequality (92nd percentile).
- Housing stability & costs: Renter share varies ~26–56% (highest Downtown/Thane). Housing cost burden spans ~21.6–31.5% (upper end in Auke Bay; mid in Downtown/Thane; lower in Lemon Creek despite higher poverty—likely reflecting lower home values there). Median home value runs ~\$300k–\$476k. Mobile homes are concentrated in Lemon Creek (~28%; 100th percentile).
- Access enablers: Uninsured ~5.2–15.9% (highest Lemon Creek); lack of internet ~2.5–22.9% (highest Downtown/Thane). Limited English proficiency is generally low (0.24–3.42%), but relatively higher in Lemon Creek. Older adults (65+) share varies ~9.5–22.7%, highest Downtown/Thane; youth share ranges ~8.9–25.9%, highest East/Lemon Creek, lowest Downtown.

### Transportation access, safety, and costs

- Access & affordability: The Transportation Access Score ranges ~0.12–0.81, with Douglas (0.81) and Lemon Creek (0.69) scoring high, and West Mendenhall (0.12) much lower. Transportation cost burden is generally low and tightly clustered (~0.10–0.15 in data units), but relatively higher in Downtown/Thane (0.15).
- Safety: Traffic fatalities vary 0–3.47 per 100k, with East Mendenhall at the upper end and Douglas/West Mendenhall at zero in the reported period.

### What these conditions mean (interpretation)

- A community with sharp intra-city contrasts. CBJ's averages will mask meaningful pockets of elevated social risk. Lemon Creek combines higher poverty, higher uninsured, higher Limited English Proficiency (LEP), older/less expensive housing (incl. mobile homes), and lower life expectancy, while Downtown/Thane mixes very old housing, high renter share, high inequality, and low youth share. West Mendenhall shows higher unemployment and flood exposure, while Douglas exhibits excellent health metrics and longevity despite higher diesel PM.
- Housing age & type matter. The very old housing stock in Downtown/Thane and pre-1980 shares elsewhere imply energy inefficiency, health risks (e.g., moisture/ventilation), and resilience challenges. The mobile-home concentration in Lemon Creek signals structural vulnerability to cold, storms, and outages.
- Flood-exposed growth areas. West and East Mendenhall show elevated property flood risk (up to 33% of local properties with risk). This interacts with airport/road proximity (especially East Mendenhall) to shape both emissions exposure and evacuation/continuity planning.
- Unequal health burden. The 72–86 year life expectancy spread indicates substantial, place-based health inequities tied to social and environmental conditions. Chronic disease and poor mental health are highest in Auke Bay/West Mendenhall, compounding environmental sensitivity for households managing illness.
- Access gaps that affect engagement. Internet gaps (up to ~23%), Limited English Proficiency (LEP) pockets, and older-adult concentrations will influence program awareness, sign-up, and sustained participation—especially where renter churn is high (e.g., Downtown/Thane).

### Intersection with Emissions Reduction Planning

- Equity targeting & sequencing: Given the stacking of vulnerabilities in Lemon Creek (poverty, uninsured, LEP, mobile homes, low life expectancy), it should be treated as a priority geography for any pollution-reduction program that claims equity outcomes. Downtown/Thane should be prioritized for old-housing health/energy co-benefits and renter-sensitive program designs. West Mendenhall merits early attention for flood-exposed properties that intersect with energy and air-quality considerations.

- Health-responsive design: Where asthma, hypertension, diabetes, and poor mental health are higher (Auke Bay/West Mendenhall), anticipate greater sensitivity to indoor air quality, heating reliability, and outage impacts. Program materials, eligibility criteria, and installation logistics should reduce cognitive/administrative load and minimize disruption for medically vulnerable households.
- Housing type & tenure fit:
  - Very old housing (esp. Downtown/Thane) may require pre-work (electrical capacity, ventilation, moisture management) to realize pollution reductions safely.
  - Renters (up to ~56%) need split-incentive-aware approaches (owner engagement, compliance with habitability rules, simple owner consent).
  - Mobile homes (Lemon Creek) require form-factors and financing that fit manufactured housing and recognize higher exposure to cold/wind.
- Flood & hazard alignment: In Mendenhall tracts, flood-exposure implies programs should consider siting, equipment elevation, and continuity so pollution-reducing assets aren't lost or disabled in events. Coordination with mitigation and insurance partners can protect investments and reduce lifecycle emissions loss from damage/replacement.
- Access & outreach tailoring:
  - Where internet access is low (e.g., Downtown/Thane) and LEP is higher (Lemon Creek), pair offline enrollment and linguistically appropriate support.
  - Older-adult pockets (Downtown/Thane) suggest in-home enrollment support and priority scheduling during extreme cold.
- Transportation context: Differences in access (low in West Mendenhall) and safety (higher fatalities in East Mendenhall) can affect workforce travel, site access, and resident participation, so mobile or neighborhood-based delivery may be more effective in certain tracts.
- Cost burden vs. ability to act: Even where energy burden appears modest in the dataset, housing cost burden (up to ~32%) plus poverty/unemployment can limit upfront participation without low-friction financing or no-cost options.
- Institutional & co-benefit framing:
  - Where schools, clinics, or community facilities sit near higher traffic or airport proximity (notably East Mendenhall), consider co-benefit narratives around reduced local pollution exposure for children and staff when prioritizing projects.
  - In Lemon Creek, linking upgrades to health and safety (e.g., moisture control, ventilation) can build trust and uptake.

### Bottom line

CBJ is a single community with distinct micro-geographies of risk. For planning and engagement, treat Lemon Creek, Downtown/Thane, and West Mendenhall as priority profiles for different reasons (stacked social risk; old/renter-heavy housing; flood-exposed properties). Tailor program delivery and communications to health status, tenure, housing age/type, flood exposure, and access barriers—so that emissions reduction investments land where they can produce both emissions and health equity gains in the next steps.



## Mitigation Strategies

### **Weatherize, then electrify homes (oil-to-heat-pump), with tailored delivery in older/renter and mobile-home areas**

Because residential No. 5 heating oil is the single largest line item in the community inventory, the fastest structural cut comes from pairing envelope upgrades with cold-climate heat pumps. Start in tracts with stacked risks—e.g., very old housing and high renter share (Downtown/Thane) and mobile-home concentrations with lower life expectancy (Lemon Creek)—using in-home enrollment, offline sign-ups, and owner-consent pathways to reach renters. This sequence (weatherization → electrification) reduces bills and indoor air pollution, lowers outage risk from fuel logistics, and leverages Juneau’s zero-carbon hydro so electrification doesn’t add scope-2 emissions. The State plan already scopes exactly these levers through AHFC Weatherization and residential beneficial electrification (Alaska Heat Smart / Southeast Conference), with quantified savings and risk mitigation—use those programs as the delivery backbone and deepen local focus in the priority tracts identified by the SDOH roll-up.

### **Public-facilities retrofits and strategic electrification (schools, state/borough assets, wastewater)**

Juneau’s SDOH shows older adults, internet gaps, and pockets of chronic disease—so reliable, clean, and affordable public facilities (schools, clinics, water/wastewater) are community health infrastructure. Accelerating retro-commissioning, envelope/HVAC upgrades, and conversion of large thermal loads to electric in hydro-served Juneau cuts fuel use and criteria pollutants where people congregate, while stabilizing operating budgets that fund services at-risk households rely on. The State plan details a ready pipeline—non-residential weatherization/EE portfolios and the Mendenhall Wastewater Treatment Plant boiler replacement (oil → electric) with quantified CO<sub>2</sub>e reductions and budget scaffolding—offering an immediate path from plan to projects in CBJ.

### **Shore-power at cruise berths (Green Corridor “first-mover”) to cut port-area emissions and exposures**

Downtown/Thane’s older housing stock and renter density sit next to heavy seasonal ship traffic. Providing shore-power at the two CBJ-owned berths shifts hoteling loads from ship diesel to AEL&P’s hydro, yielding large CO<sub>2</sub>e and local air-quality gains for adjacent neighborhoods and workers—benefits that map directly to improved outcomes for nearby at-risk residents and youth. Juneau is already framed in the State plan as a Green Corridor “first-mover” with quantified reductions, timelines, and leverage opportunities—position this as a neighborhood health measure as much as an emissions reduction measure.

### **Targeted EVSE build-out for community fleets and households, paired with mode-agnostic safety/access fixes**

Transportation is the second-largest source, dominated by gasoline. In tracts with low transportation access and higher injury rates, EVSE siting at schools, clinics, multifamily/renter hubs, and along worker commute paths reduces fuel costs and emissions while improving access. Prioritize Level-2 in neighborhoods and municipal lots (to reach renters) and DCFC to support fleets and regional travel; coordinate with outreach that addresses internet and language barriers flagged in the SDOH. The State plan’s EVSE program design (site templates, standards, and siting intent) can be localized to Juneau’s street grid and fleet profiles.

### **Community organics diversion (and regional landfill gas capture where applicable) to trim methane and costs.**

While Juneau’s purchased electricity is clean, waste methane remains a high-leverage greenhouse gas pollutant. Expanding community composting and organics diversion—already scoped in the State plan for Southeast with Juneau included—cuts methane, lowers hauling/disposal costs, and creates local soil inputs for school and community gardens (health and cost co-benefits for at-risk communities). For



regional partners that do landfill gas projects (e.g., CPL in Kenai), the plan shows large, near-term CO<sub>2</sub>e abatements that complement Southeast diversion; Juneau should anchor the organics side locally and align data/metrics with the State framework.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes for vulnerable populations in Juneau center on lower household costs, healthier indoor environments, and cleaner neighborhood air where exposures are currently highest. Sequencing weatherization with heat-pump conversion in older and renter-heavy housing reduces energy burden and winter bill volatility while improving thermal comfort and indoor air (less NO<sub>x</sub>/PM from oil combustion). In mobile-home areas, tighter envelopes and right-sized electric heating lessen cold-weather risk and moisture issues that drive respiratory illness. Public-facility upgrades (schools, clinics, water/wastewater) further enhance health and reliability for residents who rely most on these services, cutting localized diesel use and stabilizing operating budgets that fund community programs.

Transportation and community-scale measures extend these benefits. Shore power at cruise berths and targeted EV charging near multifamily housing, schools, clinics, and worker parking reduce gasoline and diesel use where at-risk households live, learn, and work—lowering neighborhood PM<sub>2.5</sub> and noise while expanding access to affordable mobility. Organics diversion can trim disposal costs and support local soils for gardens and food programs, with workforce roles that can be filled by residents. To ensure these gains accrue to at-risk communities, pair delivery with offline, multilingual enrollment; owner-consent pathways for renters; and clear metrics such as percent reduction in energy burden, at-risk share of participants and dollars, charging access within a 10-minute walk, avoided gallons of heating oil and gasoline, and measured decreases in neighborhood PM<sub>2.5</sub> and asthma-related visits.



**Benefit (Disbenefit) Quantification or Qualitative Analysis**

**Weatherize, then electrify homes (oil-to-heat-pump), with tailored delivery in older/renter and mobile-home areas**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                               | Community Benefits                                                                                                                                                    |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Addresses the residential share (~41.6% of community emissions) driven largely by No. 5 fuel oil. Illustratively: 25% adoption ≈ ~10% community reduction; 50% ≈ ~21% (assuming near-zero scope-2 from hydro and typical savings from weatherization + heat pumps). | High — Concentrates benefits in older housing, renter buildings, and mobile homes where burdens and exposures are greatest.                                           |
| Energy cost savings | High             | Heat pumps + envelope upgrades typically reduce space-heating energy 20–50%+; switching off oil removes fuel price volatility. Bill savings are largest in leaky/older units.                                                                                       | High — Reduces energy burden; pair with no-cost offers, landlord consent pathways, and in-home enrollment to reach at-risk residents.                                 |
| Health benefits     | High             | Lower indoor NO <sub>x</sub> /PM from eliminating oil combustion; better moisture/ventilation management; improved winter comfort.                                                                                                                                  | High — Tangible improvements for residents with respiratory/ cardiometabolic conditions common in priority tracts.                                                    |
| Resilience          | High             | Tight envelopes extend safe-to-occupy time in outages; fewer fuel logistics risks; modern systems improve reliability.                                                                                                                                              | High — Helps households with limited resources ride out cold snaps/outages more safely.                                                                               |
| Disbenefits/ risks  | Moderate         | Upfront disruption; electrical panel upgrades; landlord-tenant split incentives; installer capacity.                                                                                                                                                                | Mitigations: bundle measures, pre-inspect moisture/electrical, offer turnkey owner consent + tenant protections, sequenced contractor scheduling in risk-prone areas. |





**Public-facilities retrofits & strategic electrification (schools, state/borough assets, wastewater)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                              | Community Benefits                                                                                               |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Public assets are a subset of commercial + industrial (~30% combined sector). Illustratively, if 5–8% of community load sits in public facilities and achieves 30–50% savings, that’s ~1.5–4% community reduction. | High — Benefits concentrate where at-risk households use services (schools, clinics, transit, water/wastewater). |
| Energy cost savings | High             | Portfolio retro-commissioning and HVAC/envelope upgrades reduce O&M and fuel spend, stabilizing public budgets.                                                                                                    | High — Frees resources for programs used by at-risk communities; improves comfort/IAQ in shared spaces.          |
| Health benefits     | High             | Better ventilation/filtration and elimination of on-site oil reduce exposures for students, staff, and visitors.                                                                                                   | High — Improves daily environments for children, elders, and medically vulnerable residents.                     |
| Resilience          | High             | Facilities become reliable heating/cooling and shelter hubs; electrification compatible with backup generation and microgrids.                                                                                     | High — Strengthens continuity of essential services relied upon by at-risk residents.                            |
| Disbenefits/risks   | Low–Moderate     | Project delivery complexity (procurement timing, capital planning), construction disruption.                                                                                                                       | Mitigations: phased work, performance contracts, seasonal scheduling to minimize service impacts.                |

**Shore power at cruise berths (downtown “first-mover”)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                           | Community Benefits                                                                                           |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Seasonal, berth-time limited; cuts hoteling fuel by shifting to hydro. Community-wide GHG effect is moderate, but concentrated near port.       | Medium–High — Benefits accrue to adjacent neighborhoods and workers; visible community signal.               |
| Energy cost savings | Low–Moderate     | Savings accrue primarily to vessels/port operations; net local cost impacts depend on tariffs and utilization.                                  | Medium — Indirect: supports local economy while reducing exposure externalities near at-risk areas downtown. |
| Health benefits     | High             | Large local PM <sub>2.5</sub> /NO <sub>x</sub> reductions at the waterfront, improving neighborhood air and worker safety during cruise season. | High — Strong co-benefits for renters and elders in nearby older housing.                                    |
| Resilience          | Moderate         | Grid-based operations can be curtailed in constraints; infrastructure durable with proper siting.                                               | Medium — Complementary to downtown livability and emergency air-quality goals.                               |
| Disbenefits/risks   | Low–Moderate     | Capital cost; grid interconnection; alignment with cruise schedules.                                                                            | Mitigations: phased berth activation, cost-share with industry, off-peak power management.                   |

**Targeted EVSE build-out for fleets and households, paired with safety/access improvements**

| Outcome             | Potential Impact       | Quantitative / Qualitative Assessment                                                                                                                        | Community Benefits                                                                                                   |
|---------------------|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High (phased) | Transportation is ~28% of community emissions. Illustratively: 10% VMT electrified ⇒ ~2–3% community reduction; 20% ⇒ ~5–6% (hydro keeps scope-2 near zero). | High — Prioritize chargers at multifamily, schools/clinics, and worker lots to serve at-risk commuters and renters.  |
| Energy cost savings | High (user level)      | EV fueling typically cheaper per-mile than gasoline; fleet TCO benefits accrue quickly with the right duty cycles.                                           | High — Reduces mobility costs for at-risk households/fleets; pair with used-EV support and home/workplace L2 access. |
| Health benefits     | Moderate               | Local tailpipe pollutant reductions along busy corridors and near schools/clinics.                                                                           | High — Siting near at-risk housing and services maximizes exposure reductions.                                       |
| Resilience          | Moderate               | Diversifies energy supply for mobility; amenable to backup power at key chargers and depot microgrids.                                                       | Medium–High — Ensures access to essential travel during supply disruptions if chargers are strategically backed up.  |
| Disbenefits/risks   | Low–Moderate           | Upfront infrastructure, curb/lot siting conflicts, winter range impacts, equity of access.                                                                   | Mitigations: equitable siting criteria, reliability standards, cold-weather ops guidance, transparent pricing.       |

**Community organics diversion (and regional landfill gas capture where applicable)**

| Outcome             | Potential Impact                              | Quantitative / Qualitative Assessment                                                                                                                                                                        | Community Benefits                                                                                               |
|---------------------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate (local); Moderate (regional LFG) | Organics diversion cuts methane formation; absolute community impact is smaller than stationary fuel switching but meaningful per ton due to methane potency. Regional LFG capture adds scalable reductions. | Medium–High — Local programs can be designed for low-barrier participation in at-risk neighborhoods.             |
| Energy cost savings | Low–Moderate                                  | Potential hauling/disposal savings; avoided fees; compost can offset purchased soil amendments for community uses.                                                                                           | Medium — Can lower household and community program costs, especially if paired with pay-as-you-throw incentives. |
| Health benefits     | Low–Moderate                                  | Reduced odors/pests; opportunities for urban agriculture and food programs supporting nutrition.                                                                                                             | Medium — Community gardens/compost distributions can be targeted to at-risk schools and neighborhoods.           |
| Resilience          | Moderate                                      | Local material loops, workforce opportunities, and reduced dependence on long-haul disposal.                                                                                                                 | Medium — Builds community capacity and skills; supports emergency food systems.                                  |
| Disbenefits/risks   | Low                                           | Program startup logistics, contamination risk in streams.                                                                                                                                                    | Mitigations: phased roll-out, clear sorting education, targeted technical assistance in at-risk areas.           |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy burden and more predictable winter bills
- Healthier indoor air (less NO<sub>x</sub>/PM), better thermal comfort, moisture control
- Cleaner neighborhood air near homes, schools, clinics, and downtown waterfront
- Greater reliability/resilience in cold snaps and outages (tight envelopes, electrified systems)
- Better mobility access and lower per-mile travel costs with well-sited EV charging
- Upgrades to public facilities (schools, clinics, water/wastewater) that at-risk residents rely on
- Local jobs and training opportunities tied to retrofits, electrification, and organics programs
- Reduced noise from combustion equipment and traffic near sensitive sites
- Easier program access when delivery includes offline, multilingual, in-home enrollment
- Clear metrics to ensure benefits flow to vulnerable communities (energy-burden cuts, avoided gallons, proximity-based siting)

Potential disbenefits if not designed equitably:

- Rent increases or displacement pressure after building upgrades (split-incentive effects)
- Up-front costs, co-pays, or complex applications that deter participation
- Construction disruption (noise, temporary loss of parking/access) during retrofits or EVSE installs
- Landlord non-participation blocking renter benefits; uneven access in multifamily housing
- Winter performance concerns or maintenance burden for new equipment if not right-sized
- Inequitable charger placement or pricing that leaves at-risk areas underserved
- Regressive cost recovery/tariffs if program funding is spread through bills without protections
- Grid or site constraints delaying connections (especially downtown/port areas)
- Digital divide and language barriers limiting awareness and uptake
- Community mistrust if benefits aren't visible or metrics aren't reported transparently

### Path Forward

For the City and Borough of Juneau, the evidence is unambiguous: the fastest, most durable reductions come from buildings and targeted mobility, leveraged by a hydro-powered, near-zero-carbon grid. Juneau's emissions are dominated by residential heating oil and motor gasoline, with notable intra-community differences across Downtown/Thane, Lemon Creek, the Mendenhall Valley, Douglas, and Auke Bay. Prioritizing (1) weatherize-then-electrify homes (oil → cold-climate heat pumps), (2) retrofit and strategically electrify public facilities (schools, clinics, water/wastewater), and (3) deploy targeted EV charging for fleets and renters directly addresses those sources while improving affordability, indoor air, and service reliability. These benefits accrue most to at-risk households in older/renter housing and manufactured homes, and to neighborhoods near busy corridors and the waterfront.

Delivering results now depends on execution. Use renter-ready enrollment (owner consent, offline and multilingual options, in-home sign-ups), standard technical playbooks (envelope + ventilation + panels + heat pumps; retro-commission first in public buildings), and blended financing that removes up-front frictions and funds enabling work. Pair equitable EVSE siting with reliability and pricing standards. Track a concise, public set of indicators—CO<sub>2</sub>e avoided; avoided gallons of heating oil and gasoline; energy-burden cuts; measured indoor air quality/comfort gains in homes and schools; charger access within a 10-minute walk in at-risk areas; and asset uptime—and adjust course as data comes in. With this approach, Juneau can convert its hydro advantage into visible community gains: lower emissions, lower bills, healthier buildings, and stronger resilience where it is needed most.

# City and Borough of Wrangell

Population: 2,030  
Census Tract: 2275000300



wrangell.com

The City and Borough of Wrangell faces a distinctive mix of environmental, health, and socioeconomic conditions that shape how the community experiences both the risks of environmental change and the opportunities of emissions reduction. The region is vulnerable to flooding, aging housing stock, and extreme weather. Residents experience elevated rates of chronic disease compared to national averages, placing additional stress on healthcare and household well-being. At the same time, Wrangell depends heavily on petroleum for heating and transportation—key drivers of both emissions and high household costs.

In this context, emissions reductions strategies must do more than reduce emissions. They must also provide tangible benefits for vulnerable populations, who are disproportionately affected by high fuel costs, limited transportation options, and poor health outcomes. This roadmap identifies the most impactful strategies for reducing emissions while highlighting the cross-cutting benefits for health, affordability, and resilience. By aligning emissions reduction with improved outcomes for at-risk residents, Wrangell can pursue a sustainability plan that meets global goals while also delivering meaningful local improvements in daily life.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Maximizing Benefits of Existing Hydropower (reducing diesel backup, enabling electrification)
2. Building Energy Efficiency and Housing Retrofits
3. Transportation Efficiency and Electrification (especially trucks and ferries)

Taken together, these three strategies directly target the largest emission sources while also generating strong co-benefits in cost savings, health, and resilience for at-risk populations. Because Wrangell's electricity is already supplied primarily by hydropower with limited diesel backup, the most impactful mitigation strategies focus on reducing direct fossil fuel use in buildings and transportation and making fuller use of existing renewable electricity.



## Emissions Data Overview

Note that these data are for the entire Census Area, which contains three Census Tracts.

The community-scale emissions data used for this roadmap are based on regional modeling that assumes grid electricity in the area is primarily petroleum-generated. Wrangell's local reality is different: most electricity comes from hydropower, with diesel used mainly as backup. For this report we have assumed negligible emissions from electricity.

### Stationary Combustion

- Residential Sector
  - Electricity: minimal
  - Propane: 17.86 mt CO<sub>2</sub>e
  - Residual Fuel Oil No. 5: 3,682.58 mt CO<sub>2</sub>e
  - Wood & Wood Residuals: 49.89 mt CO<sub>2</sub>e
- Commercial Sector
  - Distillate Fuel Oil No. 1: 1,920.85 mt CO<sub>2</sub>e
  - Propane: 146.64 mt CO<sub>2</sub>e
  - Wood & Wood Residuals: 5.33 mt CO<sub>2</sub>e
  - Electricity: minimal
- Industrial Sector: 0%

### Transportation

By fuel type:

- Motor gasoline: 5,967.92 mt CO<sub>2</sub>e
- Diesel fuel: 1,062.94 mt CO<sub>2</sub>e
- Electricity: negligible

By vehicle type:

- Truck (commercial, heavy duty): 6,289.08 mt CO<sub>2</sub>e (89.45% of transport emissions)
- Passenger vehicles: 732.38 mt CO<sub>2</sub>e (10.42%)
- Motorcycle: 9.44 mt CO<sub>2</sub>e (0.13%)

### Electricity Generation

- Electricity consumption: 34,166.12 MWh
- Generation sources:
  - Petroleum: minimal
  - Hydro: 34,166.12 MWh → 0.00 mt CO<sub>2</sub>e (0%)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- Stationary combustion (heating, facility operations) and transportation are almost equal shares of emissions, indicating that decarbonization in both building energy and mobility is critical.
- Within stationary combustion and residual fuel oil is the largest contributor.
- Within transportation, gasoline use in trucks is by far the dominant source. Note that off-road transportation is not included in this dataset.
- Electricity generation is almost entirely hydro, contributing zero emissions in this context. Diesel generation is minimal.

## Social Determinants of Health

### Environmental Conditions

- Extreme weather vulnerability (94th percentile): Wrangell is highly exposed to extreme natural hazard events.
- Disaster losses (\$82,447 annually; 6th percentile): Economic losses are modest but reflect the borough's small size rather than low exposure.
- Flood risk (13% of properties; 73rd percentile): Flooding threatens a significant share of housing and infrastructure.
- Pollution exposures (near 0th–1st percentile nationally): Industrial pollution is minimal compared to national averages.
- Aging housing stock (56 pre-1980 homes; 81st percentile): Older homes are inefficient and may contain legacy hazards like asbestos or lead.

Implications: The main environmental risks for Wrangell stem from extreme weather hazards and vulnerable housing, rather than industrial pollution. Mitigation will be most effective when paired with housing modernization, weatherization, and resilience planning.

### Public Health Indicators

- Asthma (9.9%; 93rd percentile): Asthma is much more common in Wrangell than nationally, raising sensitivity to air quality.
- Cancer (7.5%; 98th percentile): Rates are among the highest in the nation, underscoring broad health vulnerability.
- High blood pressure (36.6%; 98th percentile): Very widespread, increasing risk of heart disease and stroke.
- Diabetes (10.7%; 98th percentile): Higher prevalence than the U.S. average, compounding chronic health burdens.
- Poor mental health (12.6%; 83rd percentile): Elevated compared to most U.S. communities.
- Life expectancy (78.7 years): Roughly aligned with national norms despite high disease prevalence.

Implications: Wrangell's heavy chronic disease burden makes the community particularly vulnerable to environmental stressors. Pollution reduction and healthier housing conditions would yield major health co-benefits.

### Socioeconomic Factors

- Poverty (32.4% below 200% Federal Poverty Level (FPL); 80th percentile): Nearly one-third of residents struggle with affordability.
- Education (11.7% without high school diploma; 86th percentile): Lower than national averages, potentially limiting access to opportunities and programs.
- Unemployment (3.3%; 39th percentile): Relatively low compared to U.S. averages, though underemployment may still be an issue.
- Insurance (15.3% uninsured; 64th percentile): Gaps in healthcare coverage create barriers to care.
- Internet access (19.4% without; 74th percentile): Limited connectivity restricts access to telehealth, education, and energy programs.
- Demographics (23% age 65+; 98th percentile): Wrangell has one of the oldest populations nationally.
- Disability (16.5%; 80th percentile): Many residents face mobility or health challenges.
- Housing (21% pre-1960; 11% mobile homes, 89th percentile): A large portion of housing is old and less resilient.

Implications: Wrangell's socioeconomic profile shows significant financial strain, aging residents, and vulnerable housing, all of which heighten environmental risks. Strategies must be affordable and accessible, ensuring at-risk households can fully participate.

### Transportation Insecurity

- Access score (0.93; 97th percentile for insecurity): Transportation options are limited, restricting daily mobility.
- Cost burden (16% of income; 80th percentile): Households spend a high share of income on transportation.
- Traffic fatalities (5.47 per 100,000; 84th percentile): Safety outcomes are worse than many U.S. communities.

Implications: Transportation in Wrangell is costly, limited, and less safe than average. Emissions reduction strategies in this domain must balance emissions reductions with improved access and affordability.

### Intersection with Emissions Reduction Planning

Wrangell's social determinants of health show a small, older, and economically vulnerable population facing high chronic disease burdens, limited transportation access, and significant exposure to environment-related risks such as extreme weather and flooding. While environmental pollution exposures are currently low, aging housing stock and energy burdens create compounding risks.

For emissions reduction planning, these conditions mean that strategies must:

- Prioritize resilience to extreme weather and flooding.
- Address health co-benefits by reducing exposures in homes and promoting healthier living conditions.
- Ensure policies are equitable, especially for low-income, older, and disabled residents.
- Adapt transportation strategies to remote, high-cost, infrastructure-limited settings.

## Mitigation Strategies

### Building Energy Efficiency and Housing Retrofits

The housing stock in the region is older, with a high proportion of pre-1980 and pre-1960 homes. Many of these homes are inefficient, driving both higher residential stationary combustion emissions and elevated energy burdens. Retrofitting homes with insulation, efficient heating systems (e.g., heat pumps), and weatherization improvements would directly reduce emissions from fuel oil, while also lowering utility costs. For at-risk households, these upgrades mean improved indoor air quality, safer housing, and reduced health stressors—especially critical given the borough's high rates of asthma, cancer, and cardiovascular disease. Because Wrangell's electricity is largely hydropower, shifting space and water heating from fuel oil or propane to efficient electric systems can significantly cut community-wide emissions while taking advantage of existing low-carbon power.

### Leveraging Hydropower and Reducing Diesel Backup

Wrangell's electricity is supplied primarily by hydropower, with diesel generation used as backup and during peak demand. This means the community already benefits from a low-carbon electricity supply, but also faces reliability and cost risks when diesel is needed. The key opportunity is to make the most of this existing clean power—by reducing reliance on diesel backup, improving system efficiency and storage, and using hydropower to displace direct fossil fuel use in buildings and transportation (for example through heat pumps and electric vehicles). For at-risk residents, this can stabilize energy costs while maintaining a clean air, low-emission power system.

### Transportation Efficiency and Electrification

Transportation accounts for ~31% of emissions, heavily concentrated in truck fleets and gasoline use. Given the high cost of transportation in remote Alaska communities, even incremental efficiency improvements can have outsized benefits. Strategies could include replacing older trucks with more efficient or hybrid/electric models, improving ferry and marine fleet efficiency, and expanding local EV charging capacity. For at-risk households, improved mobility systems reduce financial burdens from high transport costs and improve access to healthcare, food, and services.

### Resilience Against Extreme Weather

Flood risk is elevated (13% of properties, 73rd percentile nationally), and the borough scores extremely high for anticipated extreme weather change. Investments in resilient infrastructure—reinforced housing, flood-resistant siting, microgrids, and community shelters—will reduce both emissions and disaster vulnerability. For at-risk households, resilience measures mean less displacement, safer shelter, and reduced disaster recovery costs.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes for at-risk populations are central to shaping effective mitigation strategies in the region. These households face disproportionate burdens from aging housing stock, high energy and transportation costs, and elevated rates of chronic disease. By targeting building retrofits, renewable energy development, and affordable transportation improvements, emissions reduction measures can simultaneously reduce emissions and ease the cost of living. For example, upgrading older homes with efficient heating systems and weatherization not only lowers fuel use and emissions, but also reduces asthma triggers, improves indoor comfort, and lessens financial strain on households that already spend a high share of income on energy.

In addition, investments in petroleum-free electricity and transportation systems directly benefit at-risk residents by lowering exposure to combustion emissions while also stabilizing household budgets against volatile fuel costs. These improvements enhance resilience to extreme weather, reduce health risks, and strengthen community well-being. In this way, emissions reduction strategies become more than emission-reduction efforts—they become tools for delivering healthier living conditions, greater economic stability, and safer, more resilient communities for the residents who are most at risk.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

#### Building Energy Efficiency and Housing Retrofits

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                        | Community Benefits                                                                |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| GHG Reduction       | High             | Residential/commercial stationary combustion is ~69% of emissions; retrofits could cut 20–40% of this source | Direct reductions from heating oil, propane, and electricity use in at-risk homes |
| Energy Cost Savings | High             | Heating oil is costly; weatherization + efficiency lowers household bills substantially                      | Strong benefits for households with high energy burden                            |
| Health Benefits     | High             | Improved indoor air quality reduces asthma and cardiovascular stressors                                      | Greatest health gains for those with chronic diseases                             |
| Resilience          | Moderate         | Better-insulated homes more resilient to extreme cold and outages                                            | Elderly/disabled populations benefit from safer, healthier homes                  |
| Disbenefits / Risks | Low–Moderate     | Upfront costs, potential difficulty with workforce availability for retrofits                                | Risk that at-risk residents may be left out if programs lack subsidy/support      |

**Strategy 2: Leveraging Hydropower and Reducing Diesel Backup**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                    | Community Benefits                                         |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| GHG Reduction       | High             | Direct power-sector emissions are relatively small because electricity is primarily hydropower; reductions come from decreasing diesel backup use and enabling electrification of heating and transport. | Substantial, community-wide reductions                     |
| Energy Cost Savings | Moderate–High    | Long-term savings from reduced diesel runtime, improved system efficiency, and shifting heating and transport from expensive delivered fuels to local hydropower.                                        | Helps stabilize bills for households with limited income   |
| Health Benefits     | Moderate         | Reduced local combustion from diesel generators and on-site fuel use, plus indirect indoor air benefits as electrification replaces fuel-burning equipment.                                              | Less exposure for vulnerable households                    |
| Resilience          | High             | Investments in storage, load management, and backup systems increase reliability of the hydropower-based grid and reduce vulnerability to fuel supply disruptions.                                       | Improves access for isolated at-risk communities           |
| Disbenefits / Risks | Moderate         | Moderate – Upfront costs for storage, grid upgrades, and controls; risk that benefits from reduced diesel use do not immediately show up as lower rates without supportive policy and funding.           | Risk that energy transitions raise rates without subsidies |

**Strategy 3: Transportation Efficiency and Electrification**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                     | Community Benefits                                            |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| GHG Reduction       | Moderate         | Transportation is ~31% of emissions, mostly trucks; electrification/hybrids could reduce 10–20% initially | Lower exposure for those dependent on vehicles                |
| Energy Cost Savings | Moderate–High    | Reduced gasoline/diesel use lowers household and fleet costs over time                                    | Supports at-risk households facing high transport burdens     |
| Health Benefits     | Moderate         | Less air pollution from diesel and gasoline combustion                                                    | Benefits concentrated in areas with vulnerable residents      |
| Resilience          | Moderate         | EVs and efficient fleets reduce dependency on imported fuels                                              | Greater stability for remote communities                      |
| Disbenefits / Risks | Moderate–High    | High vehicle costs, limited charging infrastructure, risk of unequal access                               | At-risk residents may be excluded if upfront costs not offset |



**Resilience Investments (Flood, Extreme Weather, Microgrids)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                             | Community Benefits                                        |
|---------------------|------------------|-------------------------------------------------------------------|-----------------------------------------------------------|
| GHG Reduction       | Low              | Focused more on adaptation than mitigation                        | Indirect link through energy stability                    |
| Energy Cost Savings | Moderate         | Microgrids and distributed energy reduce outage costs             | Helps reduce recovery costs for vulnerable communities.   |
| Health Benefits     | Moderate         | Safer housing and shelters reduce disaster-related health risks   | High benefit for medically vulnerable                     |
| Resilience          | High             | Strong impact in protecting against flooding, outages, and storms | At-risk populations face greatest risk from disasters     |
| Disbenefits / Risks | Moderate         | Costly infrastructure; risk of unequal siting                     | At-risk groups must be prioritized in resilience planning |

**Cross-Cutting Community Benefits and Disbenefits**

Across all strategies, benefits for community benefits include:

- Lower household energy and transport costs
- Healthier living conditions and reduced chronic disease triggers
- Greater resilience of homes and infrastructure to flooding and storms
- Energy security through reduced reliance on imported petroleum
- Expanded access to programs via improved internet and digital tools
- Safer disaster preparedness and recovery for vulnerable populations

Potential disbenefits if not designed equitably:

- High upfront costs for retrofits, vehicles, or new infrastructure
- Risk of excluding at-risk households if programs are not designed for affordability
- Unequal benefit distribution if resilience or broadband projects favor central areas
- Short-term utility cost increases during transitions
- Workforce and resource constraints that slow project delivery



## Path Forward

The City and Borough of Wrangell is a community marked by both vulnerability and opportunity. On one hand, residents face significant risks from aging housing, high fuel costs, limited transportation access, and a heavy burden of chronic disease. On the other, the community's emissions profile is concentrated in a few key sectors—fuel-oil-heated and inefficient buildings, diesel- and gasoline-dependent transportation, and remaining diesel backup generation—offering clear and targeted opportunities for action.

The analysis shows that three strategies stand out as both high-impact for GHG reduction and high-benefit for local households: retrofitting and electrifying housing to reduce direct fuel use, improving transportation efficiency and electrification, and optimizing the hydropower-based electricity system to minimize diesel backup and support these transitions. Together, these measures address more than two-thirds of Wrangell's emissions while also reducing household costs, improving health outcomes, and strengthening resilience against extreme weather.

Looking forward, the path for Wrangell is to build a phased, community-driven roadmap that pairs emissions reduction with tangible local improvements:

- Near-term actions can focus on weatherization, energy efficiency programs, and building readiness for renewables—low-regret measures that deliver immediate savings and health benefits.
- Medium-term actions should scale local renewable generation and expand efficient, affordable transportation options, ensuring that at-risk populations are able to participate fully.
- Long-term actions should invest in resilient infrastructure—microgrids, flood protections, broadband expansion—that safeguard residents and make the community more self-reliant.

By integrating health, cost, and resilience outcomes into sustainability actions, Wrangell has the opportunity to design a mitigation plan that is not just about meeting state and federal emissions reduction goals, but about delivering lasting, visible improvements for its people. This approach will ensure that the benefits of decarbonization are shared broadly, that vulnerable households are protected, and that Wrangell emerges stronger, healthier, and more resilient.



wrangell.com



# Yakutat Borough

Population: 637

Census Tract: 2282000100



yakutat.com

Yakutat faces a unique set of challenges at the intersection of environment, health, and community well-being. With a population of just over 600 residents, the borough experiences some of the highest energy burdens in the nation, relying heavily on imported petroleum for both household heating and local electricity generation. At the same time, many residents live in older, less efficient housing stock and face elevated risks from flooding and extreme weather. Health indicators point to above-average prevalence of chronic diseases such as asthma, heart disease, and diabetes, conditions that can be worsened by poor indoor air quality and environmental stressors.

Against this backdrop, strategies to reduce emissions must be designed to do more than meet emissions reduction targets—they must also strengthen resilience, lower costs, and improve outcomes for at-risk households. By aligning emissions reduction with local needs, Yakutat has the opportunity to chart a pathway that simultaneously cuts reliance on fossil fuels, stabilizes household budgets, and enhances health and safety. The following analysis identifies the most impactful strategies, weighing both their emissions reduction benefits and their broader implications for community wellbeing.

## Overall Assessment

Most impactful, high-benefit strategies for indoor air quality reduction and community co-benefits:

1. Transitioning Residential Heating Away from Fuel Oil
2. Reducing Petroleum-Based Electricity Generation (Local Renewables + Storage)
3. Housing Improvements & Hazard Mitigation (Weatherization, Retrofits, Flood-Hardening)

Together, these three strategies target Yakutat's biggest emissions sources (heating fuel, petroleum electricity, and inefficient housing) while producing the strongest co-benefits in cost savings, resilience, and health.

## Emissions Data Overview

Total Modeled Emissions: 8,311 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (57.95%)

- Residential sector (~ 36.02% of total emissions)
  - Residual Fuel Oil No. 5: ~ 2,560.65 mt CO<sub>2</sub>e (~ 30.81%)
  - Electricity (on-site or attributed): ~ 401.42 mt CO<sub>2</sub>e (~ 4.83%)
  - Natural Gas: ~ 23.11 mt CO<sub>2</sub>e (~ 0.28%)
  - Wood & Wood Residuals: ~ 8.20 mt CO<sub>2</sub>e (~ 0.10%)
- Commercial sector (~ 21.93% of total emissions)
  - Electricity: ~ 1,260.24 mt CO<sub>2</sub>e (~ 15.16%)
  - Distillate Fuel Oil No. 1: ~ 521.51 mt CO<sub>2</sub>e (~ 6.27%)
  - Propane: ~ 39.81 mt CO<sub>2</sub>e (~ 0.48%)
  - Wood & Wood Residuals: ~ 1.45 mt CO<sub>2</sub>e (~ 0.02%)
- Industrial sector
  - Contributes 0% in this model (no stationary combustion emissions modeled for industrial uses)

### Transportation (42.05%)

- By fuel type
  - Motor Gasoline: ~ 2,889.47 mt CO<sub>2</sub>e (~ 34.77%)
  - Diesel Fuel: ~ 605.31 mt CO<sub>2</sub>e (~ 7.28%)
  - Electricity (for vehicles): ~ 0.01 mt CO<sub>2</sub>e (negligible)
- By vehicle type
  - Trucks (heavy duty, freight, etc.): ~ 3,338.47 mt CO<sub>2</sub>e (~ 95.53% of transportation emissions)
  - Passenger vehicles: ~ 152.00 mt CO<sub>2</sub>e (~ 4.35%)
  - Motorcycles: ~ 4.32 mt CO<sub>2</sub>e (~ 0.12%)

### Electricity Generation

- Electricity use total: 5,769.69 MWh
- Fuel source: Petroleum
- Emissions: ~ 1,661.67 mt CO<sub>2</sub>e (~ 100% of local electricity generation)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- The largest single share of emissions comes from stationary combustion—particularly residential heating with residual fuel oil (No. 5). This suggests that space heating, water heating, or heating systems using heavy fuel oil are major contributors.



- Electricity use in the commercial sector is also a substantial contributor (over 15% of total emissions), indicating that commercial buildings or facilities consume electricity in ways that drive emissions when generated from local petroleum sources.
- Transportation is also a major share (over 40%), and within it, truck / heavy-duty vehicle fuel use dominates—likely reflecting freight, goods movement, or other heavy transport needs in this region.
- Local electricity generation is 100% petroleum-based in this model, adding a nontrivial share (~16.66%) to the community's emissions footprint.

## Social Determinants of Health

### Environmental Conditions

- Flood Risk: 17% of local properties at risk; 82nd percentile nationally → High vulnerability to flooding.
- Extreme Weather: Anticipated change score of 36.93 → Signals increasing instability in local weather.
- Housing Age: 71st percentile for pre-1980 homes; 10% pre-1960 → Likely structural vulnerabilities, energy inefficiency, and possible lead/asbestos risks.
- Hazardous Sites: Very low proximity to hazardous facilities; but one Formerly Used Defense Site present → Legacy contamination potential.
- Air Quality: Diesel PM exposure and toxic releases both near zero; cancer risk index moderate (8.00).

Implications: Yakutat's most pressing environmental risks stem from flooding and aging housing rather than industrial pollution. Any emissions reduction plan must integrate flood resilience and housing upgrades alongside pollution reduction.

### Public Health Indicators

- Asthma: 5.1% prevalence; 57th percentile → Moderate concern given indoor heating sources.
- Diabetes: 5.45%; 62nd percentile → Above average, linked to lifestyle and access to care.
- High Blood Pressure: 17.16%; 58th percentile → Elevated, signaling cardiovascular vulnerability.
- Heart Disease: 60th percentile nationally → Significant chronic disease burden.
- Mental Health: 6.7% poor mental health prevalence; 53rd percentile → Indicates moderate challenges.
- Cancer Prevalence: 2.95%; 57th percentile → Comparable to national midrange.
- Life Expectancy: Data unavailable, limiting full context.

Implications: Chronic conditions are widespread and can be worsened by environmental stressors (e.g., poor housing, indoor air pollution). Emissions reduction actions that reduce particulate exposure and improve housing quality will also support better health outcomes.

### Socioeconomic Factors

- Poverty: 41% live below 200% Federal Poverty Level (FPL); 90th percentile nationally → Deep economic vulnerability.
- Unemployment: 5.8%; 69th percentile → Above national average, reducing household stability.
- Uninsurance: 19.8%; 85th percentile → High health access challenges.
- Energy Burden: 5% of income; 92nd percentile → Among the highest nationally, straining households.
- Internet Access: 16.7% lack internet; 67th percentile → Limits education, jobs, and telehealth access.
- Housing Tenure: 48% renter-occupied; 77th percentile → High proportion of households with limited control over energy or housing upgrades.
- Education: 5.6% without a high school diploma; 43rd percentile → Educational attainment relatively average.

Implications: Economic strain is a major barrier to resilience. High energy costs and insurance gaps make at-risk households especially vulnerable to both environmental and health risks. Strategies must focus on affordability and access.



### Demographic Characteristics

- Age Distribution: 22.8% under 18, 14% over 65 → Significant youth and elder populations.
- Disability: 7.7% of residents; 16th percentile → Smaller share than national average, but still relevant for planning.
- Limited English Proficiency: 0.6%; 53rd percentile → Not a major barrier locally.
- Housing Type: 4.8% mobile homes; 69th percentile → Higher vulnerability to storm/flood damage.

Implications: A relatively large share of Yakutat residents are in age groups more sensitive to environmental stressors (children and elders). Emissions reduction plans must include protections and support for these populations, with housing security as a central concern.

### Transportation Insecurity

- Transportation Access Score: Below average (39th percentile) → Indicates geographic and mobility challenges.
- Transportation Cost Burden: High (79th percentile) → Significant share of income devoted to transport.
- Traffic Safety: No fatalities reported → Not a current issue.

Implications: Transportation costs weigh heavily on households, particularly those with lower incomes. Emissions reduction efforts in this sector must focus on affordability and access, not just emissions reduction.

### Intersection with Emissions Reduction Planning

- High energy burden (92nd percentile nationally) means strategies that reduce fuel oil dependence (e.g., heating transition, efficiency upgrades, renewables) will directly relieve financial strain while cutting emissions.
- Flood risk (82nd percentile) makes housing resilience measures essential to ensure sustainability investments aren't undermined by damage and displacement.
- Older housing stock (71st percentile pre-1980s) is both inefficient and vulnerable, creating opportunities for weatherization and retrofits that reduce GHGs while improving safety and health.
- Chronic health burdens (diabetes, asthma, cardiovascular disease above average) highlight the importance of reducing combustion-related air pollution and improving indoor air quality through clean energy transitions.
- High poverty and renter rates (41% below 200% Federal Poverty Level (FPL); 48% renters) require targeted, affordable program design to ensure at-risk households can access and benefit from upgrades.
- Petroleum-based electricity (100% of local generation) creates both an environmental and cost vulnerability; renewable energy investments reduce emissions and stabilize household budgets.
- Transportation cost burden (79th percentile) indicates that emissions reduction in this sector must also improve affordability, such as through community fleets or more efficient supply logistics.
- Youth and elder populations (23% under 18, 14% over 65) are more sensitive to both environmental hazards and cost stressors, making them priority groups for resilient housing, reliable power, and clean air.

### Mitigation Strategies

#### Transitioning Residential Heating Away from Fuel Oil

Residential heating is the single largest emissions source in Yakutat, driven by widespread reliance on residual fuel oil (No. 5). At the same time, households face very high energy burdens (92nd percentile nationally), which strains already limited incomes. A strategy that expands access to clean, affordable alternatives—such as electric heat pumps, biomass district systems, or renewable-powered microgrids—would directly reduce emissions while lowering household fuel costs. For at-risk households, this represents not only cleaner air but also more stable monthly budgets, making energy transitions a direct contributor to health and financial security.

### Reducing Petroleum-Based Electricity Generation

Yakutat's electricity is 100% petroleum-derived, accounting for ~16.6% of emissions. This dependence exposes the community to volatile fuel costs, shipping vulnerabilities, and local pollution risks. Expanding local renewable generation (wind, solar, hydropower, or tidal where feasible) paired with storage can dramatically reduce emissions while making the grid more resilient to storms and fuel supply disruptions. For at-risk residents, reduced reliance on imported fuels could mean lower, more predictable electricity bills, along with improved reliability that lessens disruptions during extreme weather events.

### Addressing Transportation Emissions with Local Context

Transportation emissions are dominated by heavy-duty trucks, reflecting the importance of freight and supply delivery. While full electrification of long-haul freight may be premature, strategies could focus on improving efficiency in supply chains, piloting renewable diesel, or introducing hybrid/electric options for local fleets (municipal, school buses, or community shuttles). For residents facing high transportation cost burdens (79th percentile), investments in shared mobility or community vehicles could reduce costs while cutting emissions. Ensuring reliable transport options also improves access to healthcare and services for at-risk populations, directly linking emissions reduction to improved quality of life.

### Housing Improvements and Hazard Mitigation

Yakutat has an elevated proportion of pre-1980s housing (71st percentile nationally) and a share of pre-1960s stock. These homes are often less energy efficient and more vulnerable to flooding—17% of properties are at risk. Strategies that combine weatherization, energy retrofits, and flood-proofing would reduce emissions from heating, improve indoor air quality, and protect against displacement. For at-risk households, upgraded housing would mean healthier living conditions, reduced energy expenses, and greater protection from severe environmental events.

### Health-Centered Pollution Mitigation

Chronic diseases such as diabetes, asthma, and heart disease occur in Yakutat at higher-than-average levels. Pollution mitigation strategies that reduce diesel particulates, fuel combustion, and poor indoor air quality directly benefit these populations. For at-risk communities with limited insurance coverage (84th percentile uninsured), preventive health gains from cleaner air and improved housing conditions can reduce reliance on costly emergency care, fostering long-term wellbeing.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes for at-risk residents in Yakutat can be realized by linking emissions reduction directly to everyday challenges—especially high household energy costs, limited healthcare access, and aging, inefficient housing. For many residents, heating with fuel oil or relying on petroleum-based electricity strains family budgets and exposes them to price volatility. By expanding access to cleaner, more affordable alternatives such as renewable electricity and energy-efficient housing upgrades, households can experience lower monthly costs, healthier indoor environments, and greater stability during extreme weather. These improvements address both emissions reduction and the lived economic pressures that weigh most heavily on vulnerable residents.

At the same time, at-risk populations in Yakutat are disproportionately affected by chronic conditions like asthma, heart disease, and diabetes, which can be exacerbated by pollution and unstable living conditions. Mitigation strategies that reduce diesel particulates, improve air quality, and secure housing against flooding directly translate into better health outcomes and reduced reliance on costly emergency care. For communities with high rates of uninsurance and transportation cost burdens, this means not just environmental gains, but tangible improvements in wellbeing, financial resilience, and long-term security. By focusing on these linkages, emissions reduction actions become a pathway toward greater equity in health, housing, and economic stability.

**Benefit (Disbenefit) Quantification or Qualitative Analysis****Transitioning Residential Heating Away from Fuel Oil**

| Outcome             | Potential Impact                                                                                      | Quantitative / Qualitative Assessment                                                                                          | Community Benefits                                                                                                                                    |
|---------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High — up to ~2,560 mt CO <sub>2</sub> e/yr if oil heat (No. 5) is largely displaced                  | Residual fuel oil is the largest single residential source; heat pumps/biomass/district heat could remove most of it over time | Reduces pollution exposure in older homes; aligns with high energy burden and low incomes; benefits renters with program design that includes rentals |
| Energy cost savings | High — 20–50% heating cost reduction typical when moving from oil to high-efficiency electric/biomass | Modeled/observed ranges in AK communities; exact \$ varies with fuel price and load                                            | Biggest bill relief goes to low-income households; frees cash for essentials; can layer with assistance programs                                      |
| Health benefits     | Moderate–High                                                                                         | Less indoor combustion/soot; better thermal comfort and IAQ; fewer missed work/school days                                     | At-risk households with higher chronic disease rates see outsized gains from cleaner, steadier heat                                                   |
| Resilience          | Moderate                                                                                              | Less dependence on delivered fuels; fewer supply shocks; heat pumps still need reliable power                                  | Pairing with backup/thermal storage protects vulnerable households during outages                                                                     |
| Disbenefits/risks   | Low–Moderate                                                                                          | Upfront costs; electrical panel upgrades; performance at very low temps; renter split-incentives                               | Without subsidies/tenant protections, improvements could bypass or burden I households                                                                |



**Reducing Petroleum-Based Electricity Generation (local renewables + storage)**

| Outcome             | Potential Impact                                                                                    | Quantitative / Qualitative Assessment                                                                     | Community Benefits                                                                                              |
|---------------------|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High — up to ~1,660 mt CO <sub>2</sub> e/yr if local generation shifts from petroleum to renewables | Petroleum currently provides essentially all local generation; even partial replacement yields large cuts | Air-quality and sustainability benefits near population; aligns with at-risk community exposure reduction goals |
| Energy cost savings | Moderate–High (trajectory)                                                                          | Near-term capex; long-term fuel savings hedge against diesel volatility                                   | Stabilizes bills for low-income customers; can reduce arrearages and shutoffs over time                         |
| Health benefits     | Moderate                                                                                            | Fewer generator emissions and fuel handling; noise reduction                                              | Benefits downtown/nearby residents and sensitive groups                                                         |
| Resilience          | High                                                                                                | Local generation + storage mitigates storm/freight disruptions; supports critical services                | Keeps clinics, shelters, water systems online for at-risk residents                                             |
| Disbenefits/risks   | Low–Moderate                                                                                        | Siting, intermittency, O&M capacity; tariff design must protect affordability                             | Poorly designed cost recovery could raise rates; ensure at-risk bill protections                                |

**Transportation Emissions (freight efficiency, municipal/light-duty electrification, cleaner fuels)**

| Outcome             | Potential Impact                                                                                                | Quantitative / Qualitative Assessment                                                                               | Community Benefits                                                                                  |
|---------------------|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate — address ~3,490 mt CO <sub>2</sub> e/yr (gasoline ~2,890; diesel ~605); near-term cuts likely partial | Heavy trucks dominate; prioritize efficiency, route optimization, renewable diesel pilots, and public/municipal EVs | Cleaner buses/shuttles and community cars reduce exposure and improve access for at-risk residents  |
| Energy cost savings | Moderate                                                                                                        | Fleet fuel/maintenance savings for municipal and local fleets; private savings where EV use is feasible             | Lower transport costs improve access to work/healthcare; targeted programs prevent burden shifting  |
| Health benefits     | Moderate                                                                                                        | Less tailpipe PM/NO <sub>x</sub> near homes, schools, and walkable areas                                            | Asthma/cardiovascular co-benefits accrue to sensitive at-risk groups                                |
| Resilience          | Moderate                                                                                                        | Diversifies fuels; reduces dependence on shipped fuels; critical-service fleets more reliable                       | Ensures essential mobility for medical access and emergencies                                       |
| Disbenefits/risks   | Low–Moderate                                                                                                    | Charger siting/uptime; upfront vehicle costs; renewable diesel supply; cold-weather range                           | If infrastructure clusters in higher-income zones, at-risk areas could miss benefits—site equitably |

**Housing Improvements & Hazard Mitigation (weatherization, retrofits, flood-hardening)**

| Outcome             | Potential Impact                                                           | Quantitative / Qualitative Assessment                                                                    | Community Benefits                                                                                           |
|---------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High                                                              | Efficiency and envelope upgrades cut heating fuel use across older stock; overlaps with Strategy 1       | Prioritize older, leaky homes and rentals occupied by low-income households                                  |
| Energy cost savings | High — 20–35% typical whole-home savings; higher in worst-performing homes | Weatherization routinely achieves double-digit reductions; biggest gains in pre-1980s stock              | Deeply lowers bills for high-burden households; reduces energy insecurity                                    |
| Health benefits     | High                                                                       | Mold/moisture remediation, ventilation, safer indoor temps; fewer exacerbations of asthma/heart disease  | Strong benefits where un/under-insured rates are high; lowers acute care visits                              |
| Resilience          | High                                                                       | Flood-proofing and durability reduce displacement risk; efficiency + backup improves sheltering in place | Protects at-risk households most exposed to flood risk and housing instability                               |
| Disbenefits/risks   | Low–Moderate                                                               | Contractor capacity; landlord pass-throughs; temporary displacement during work                          | Guardrails needed to prevent rent hikes or “renovictions”; provide tenant protections and relocation support |

**Health-Centered Pollution Mitigation (diesel PM reduction, IAQ, targeted protections)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                        | Community Benefits                                                                |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate     | Primarily an air-toxics/criteria-pollutant focus; some GHG co-benefits from cleaner fuels and reduced idling | Co-benefits accrue in at-risk areas closest to sources                            |
| Energy cost savings | Low              | Limited direct bill impacts                                                                                  | Indirect savings via fewer missed workdays/medical travel                         |
| Health benefits     | High             | Focused PM/NOx reductions, ventilation/IAQ upgrades in homes and schools; portable HEPA for smoke events     | Largest health gains for low-income elders, kids, and people with chronic disease |
| Resilience          | Moderate         | Cleaner backup generation, smoke-ready shelters, IAQ kits boost readiness for extreme events                 | Prioritizes medically vulnerable at-risk residents                                |
| Disbenefits/risks   | Low              | Program participation and maintenance; ensuring sustained funding                                            | Deliver at no/low cost to at-risk households to avoid barriers                    |



### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy burdens through reduced fuel oil dependence and improved efficiency.
- More stable and predictable utility bills by shifting away from imported petroleum.
- Improved indoor air quality and healthier homes from weatherization, ventilation upgrades, and reduced combustion.
- Reduced health risks for those with asthma, heart disease, and diabetes through lower exposure to particulates and toxins.
- Greater resilience to storms and supply disruptions with local renewables, storage, and resilient housing.
- Improved mobility and access with lower-cost, reliable transportation options that connect households to jobs, healthcare, and education.
- Housing security and comfort through flood-proofing and retrofits, protecting vulnerable residents from displacement.

Potential disbenefits if not designed equitably:

- Upfront costs and financing barriers could limit access if subsidies are not designed for at-risk households.
- Risk of rent increases or “renovictions” if landlords pass retrofit costs onto tenants.
- Unequal access to new technologies (heat pumps, EV chargers) if deployment prioritizes higher-income households.
- Strain on local capacity (contractors, technicians, utility staff) that could delay or reduce program reach to vulnerable residents.
- Reliability risks if new systems (renewables, EV infrastructure, advanced heating) are not paired with adequate backup and maintenance support.
- Tariff or rate design pitfalls where poorly structured cost recovery could inadvertently raise bills for at-risk households.

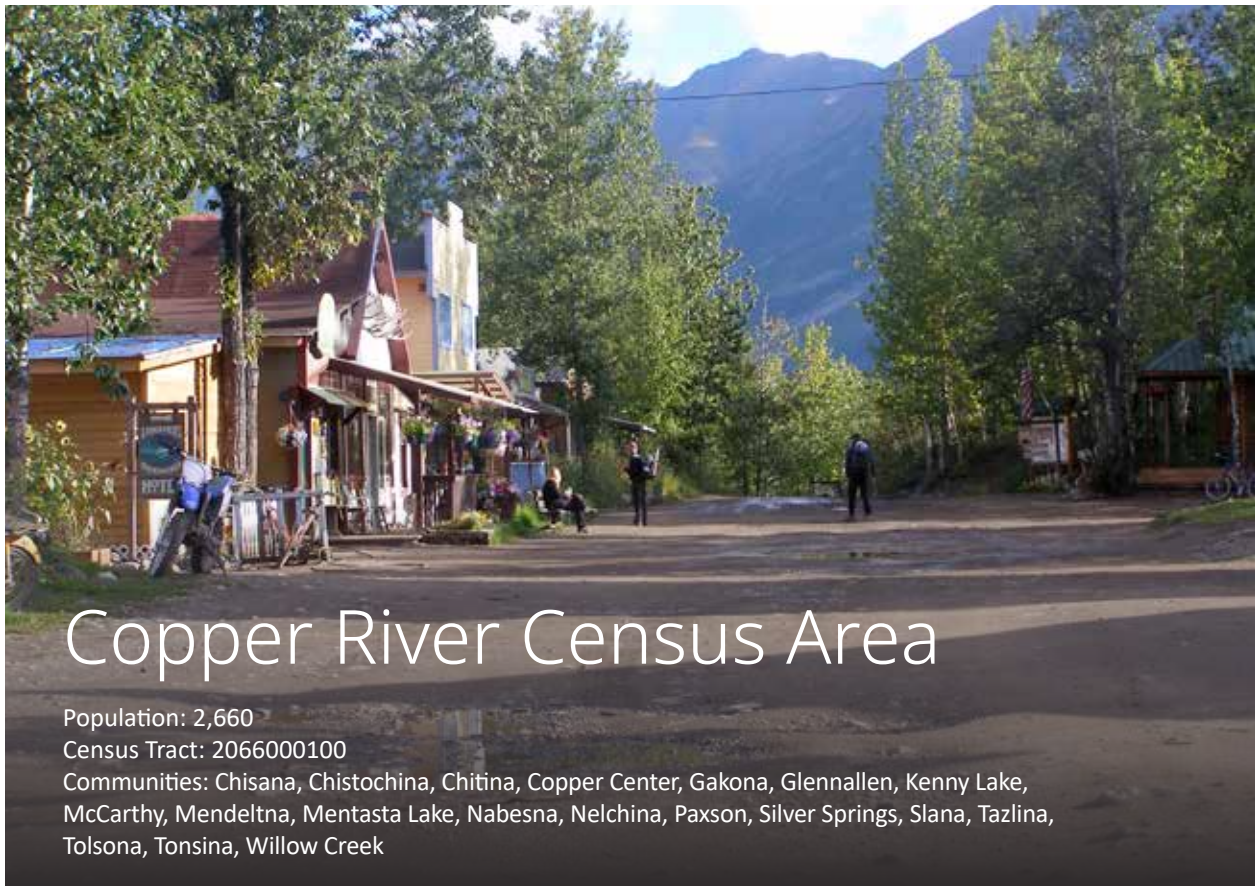
### Path Forward

Yakutat’s emissions profile is shaped by a small set of dominant factors: heavy reliance on residual fuel oil for heating, petroleum-based electricity generation, and the inefficiency of older housing stock. Together, these sources drive the majority of criteria pollutants and greenhouse gas emissions while also compounding financial and health burdens for residents, particularly those in vulnerable groups. The strategies identified—transitioning heating systems, expanding renewable energy generation, and upgrading homes for efficiency and resilience—stand out not only for their high potential to reduce emissions, but also for their ability to deliver immediate and tangible benefits in household affordability, public health, and community security.

The path forward will require balancing near-term, achievable improvements with long-term transformation. Weatherization and heating transitions can begin quickly with targeted investments and incentives, prioritizing the households facing the highest costs and risks. At the same time, planning and investment in renewable generation and storage will lay the foundation for durable, community-wide resilience, insulating Yakutat from fuel price volatility and supply chain disruptions. Embedding fair outcomes into each step will ensure that the benefits of emissions reduction action—lower bills, healthier homes, and stronger protections from extreme weather—are shared broadly and equitably across the community.

By pursuing these strategies in a phased, coordinated manner, Yakutat can simultaneously advance emissions reduction goals and secure a healthier, more resilient future for its residents.

McCarthy: By James Brooks, wikimedia



## Copper River Census Area

Population: 2,660

Census Tract: 2066000100

Communities: Chisana, Chistochina, Chitina, Copper Center, Gakona, Glennallen, Kenny Lake, McCarthy, Mendeltna, Mentasta Lake, Nabesna, Nelchina, Paxson, Silver Springs, Slana, Tazlina, Tolsona, Tonsina, Willow Creek

The Copper River Census Area faces distinct challenges at the nexus of environmental change, high energy costs, and community health. Emissions in the broader Valdez–Cordova region are driven by stationary fuel combustion for heating, diesel-based transportation, and petroleum-fired electricity generation. At the same time, Copper River households endure one of the highest energy burdens nationally, alongside limited healthcare access, significant transportation insecurity, and high rates of poverty and disability. These social and economic pressures place vulnerable groups—particularly low-income households, people with disabilities, and Indigenous communities—at greater risk from both environmental change and the costs of transition.

In this setting, mitigation strategies cannot be judged solely by their emissions reduction potential. They must also be evaluated for their affordability, accessibility, health impacts, and resilience benefits, with explicit attention to how they affect vulnerable populations. This analysis provides a combined qualitative and quantitative assessment of the most relevant strategies for Copper River, identifying both benefits and disbenefits to guide equitable and effective emissions reduction planning.

### Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Heating Transition (weatherization + fuel switching)
2. Transportation System Improvements (heavy-duty fleet + community transit)
3. Electricity Generation Transition (renewables replacing petroleum)

The strategies with the highest impact are those that tackle heating, transportation, and diesel-based electricity. These address the largest emission sources while delivering direct affordability, health, and resilience benefits to at-risk communities—making them the cornerstone of an equitable sustainable energy plan.

## Emissions Data Overview

Note that the following data are for the entire 2010 Valdez-Cordova Census Area, which includes three 2020 Census Tracts (Cordova, Valdez/Western Prince William Sound, and Copper River).

Total Modeled Emissions: 155,891 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion Detail (53.39 %)

Breakdown by sector & fuel:

- Residential (~ 27.16 % of total emissions)
  - Electricity: 8,280.16 mt (~ 5.31 %)
  - Natural gas: 1,432.76 mt (~ 0.92 %)
  - Propane: 779.93 mt (~ 0.50 %)
  - Residual Fuel Oil No. 5: 31,638.50 mt (~ 20.3 %)
  - Wood & wood residuals: 204.56 mt (~ 0.13 %)
- Commercial (~ 12.37 % of total)
  - Distillate Fuel Oil No. 1: 8,869.32 mt (~ 5.69 %)
  - Natural gas: 491.84 mt (~ 0.32 %)
  - Propane: 677.08 mt (~ 0.43 %)
  - Electricity: 9,226.50 mt (~ 5.92 %)
  - Wood & residuals: 24.62 mt (~ 0.02 %)
- Industrial (~ 13.86 % of total)
  - Distillate Fuel Oil No. 2: 20,778.94 mt (~ 13.33 %)
  - Propane: 821.74 mt (~ 0.53 %)

### Transportation Detail (46.61 %)

- By fuel / vehicle type:
  - Diesel fuel: 29,686.10 mt (~ 19.04 %)
  - Motor gasoline: 42,977.99 mt (~ 27.57 %)
  - Electricity: 0.83 mt (negligible)
- By vehicle class:
  - Trucks: 60,255.11 mt (~ 82.92 % of transportation emissions)
  - Passenger vehicles: 12,087.53 mt (~ 16.63 %)
  - Motorcycles: 322.29 mt (~ 0.44 %)

### Electricity Generation

- Total electricity used: 115,023.44 MWh
- Generation sources & emissions:
  - Hydro: 51,760.55 MWh → 0 mt CO<sub>2</sub>e
  - Petroleum (oil): 57,511.72 MWh → 16,563.37 mt CO<sub>2</sub>e (~ 94.61 % of generation emissions)
  - Natural gas: 4,600.94 MWh → 944.11 mt CO<sub>2</sub>e (~ 5.39 %)

Thus, petroleum-based generation is the primary driver of electricity emissions, despite hydro capacity.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset

### Key Takeaways

- The emissions profile is dual-driven: although stationary combustion is slightly higher, transportation is nearly as large a share—meaning decarbonization efforts must address both buildings/fuel use and mobility.
- Heavy reliance on residual fuel oil and petroleum-based electricity generation points to fossil fuel dependency. Transitioning away from these would likely yield significant emissions reductions.
- The dominance of truck/diesel transport means freight, heavy vehicles, or infrastructure for commercial transport are critical leverage points.

## Social Determinants of Health

### Environmental Conditions

- Extreme Weather (65.34) – The area has a moderately high anticipated change in extreme weather, which may increase vulnerability to storms, temperature swings, or wildfires.
- Disaster Loss (\$418,296.60; 25.57 percentile) – Disaster costs are lower compared to other areas nationally, but still represent financial and infrastructure risk.
- Air Quality (Diesel PM: 0.00; Air Toxics Cancer Risk: 8.00) – Very low diesel particulate exposure suggests limited traffic or industrial emissions, though cancer risk percentile indicates moderate vulnerability.
- Hazardous Sites – Proximity to hazardous sites (35.23 percentile) is limited, though the presence of formerly used defense sites is notable.
- Housing Risks – Pre-1980s housing (31.98 units; 35.80 percentile) indicates some aging housing stock, which can pose health and energy efficiency challenges.
- Transportation-Linked Exposure – Low proximity to high-volume roads (40.91 percentile) and airports (10.80 percentile) suggests reduced exposure to traffic-related pollutants.

Implications: Environmental risks in Copper River are tied more to aging infrastructure and increasing extreme weather than to industrial pollution. This means that strengthening local infrastructure and preparedness, rather than focusing solely on industrial cleanup, will be key to protecting long-term health and sustainability.

### Public Health Indicators

- Chronic Disease – Asthma (4.95%), cancer (3.15%), diabetes (5.15%), and high blood pressure (18.0%) show moderate prevalence, with percentiles clustering around the 55–62 range nationally. Heart disease percentile (67.0) is higher, indicating concern.
- Mental Health – Poor mental health prevalence (6.40%; 47.73 percentile) is slightly below the national midpoint, though likely underreported in rural contexts.
- Life Expectancy (79 years) – Slightly above U.S. average, suggesting strong baseline health outcomes despite risk factors.
- Health Disparities – With relatively high chronic disease percentiles, long-term healthcare needs may place pressure on limited regional resources.

Implications: While life expectancy is relatively strong, chronic diseases, particularly cardiovascular-related, represent substantial risk. This increases the importance of healthcare access, prevention, and healthy environments to mitigate long-term burdens.

### Socioeconomic Factors

- Poverty (30.30%; 72.73 percentile) – A significant proportion of residents live below 200% of the federal poverty line.
- Education (4.60% without HS diploma; 28.98 percentile) – Educational attainment is relatively strong compared to national levels, which may support workforce resilience.
- Employment (3.40% unemployment; 41.19 percentile) – Employment appears relatively stable, though rural job structures may mask underemployment.
- Housing – Homeownership is relatively strong, with a median home value of \$208,500. Housing cost burden is low (15.91 percentile).
- Insurance Gaps (19.90%; 85.23 percentile) – A very high uninsured rate indicates barriers to healthcare access.
- Digital Divide (23.90%; 82.10 percentile lack internet) – Limited broadband significantly constrains education, employment, and telehealth.



- **Energy Burden** (6.0; 96 percentile) – Households face very high energy costs relative to income, straining financial stability.
- **Demographics** – A relatively young population (27.8% under 17) combined with 12.3% older adults highlights both childcare and eldercare needs.
- **Disability** (16.30%; 78.98 percentile) – Disability prevalence is high, requiring attention to accessibility in services and infrastructure.

Implications: Socioeconomic stressors, especially poverty, high uninsured rates, digital divides, and extremely high energy costs, weigh heavily on the community's resilience. Addressing affordability and access issues is critical to achieving equitable health outcomes.

### Transportation Insecurity

- **Access Score** (0.81; 92.26 percentile) – Extremely high transportation insecurity indicates major challenges in reaching essential services.
- **Cost Burden** (0.15; 67.05 percentile) – While costs are somewhat high, the greater issue is physical access.
- **Traffic Fatalities** (7.41 per 100,000; 90.91 percentile) – Fatality rates are high, reflecting road safety and emergency response challenges in remote areas.

Implications: Transportation insecurity creates barriers to healthcare, employment, and education access while increasing risk exposure. This further compounds socioeconomic and health disparities in the region.

### Intersection with Emissions Reduction Planning

The conditions in Copper River suggest that emissions reduction planning must be tightly aligned with socioeconomic resilience and health equity goals:

- **Energy Burden & Affordability** – Extremely high energy costs mean that clean energy transitions must prioritize affordability and efficiency improvements, not just emissions reduction.
- **Healthcare & Chronic Disease** – Pollution reduction measures that also reduce cardiovascular and respiratory risks could yield significant co-benefits.
- **Transportation Insecurity** – Any strategy must recognize the barriers of distance and access, integrating localized solutions like community transit or decentralized energy.
- **Poverty & Digital Divide** – Emissions reduction solutions that demand upfront investments or digital access risk widening inequalities unless targeted supports are built in.
- **Extreme Weather & Aging Housing** – Adaptation measures for homes and infrastructure must be coupled with pollution reduction efforts to ensure resilience.

Overall: Copper River's social determinants highlight a community that is both vulnerable to environmental change and constrained by high costs of living and limited access to services. Emissions reduction strategies will need to be equity-centered, ensuring that solutions do not deepen existing disparities but instead improve long-term health, economic stability, and resilience.

## Mitigation Strategies

### Residential and Commercial Heating Transition

A large share of emissions in the stationary sector comes from residual and distillate fuel oil use in homes and commercial buildings. At the same time, households face extremely high energy burdens—among the highest nationally. This makes weatherization, insulation upgrades, and conversion to electric heat pumps or biomass alternatives especially powerful strategies. Not only would these steps reduce reliance on imported fuels and lower emissions, but they would also ease financial strain, improve indoor air quality, and strengthen resilience against extreme cold. For lower-income or uninsured households, equitable access to financing and support programs will be essential to ensure these benefits are shared across the community.



### Transportation System Improvements

Transportation is the other major source of emissions, with trucks and heavy-duty vehicles accounting for over 80% of the sector's output. Yet the region struggles with transportation insecurity, high costs, and high fatality rates. This suggests that the most effective mitigation measures will come from localized, community-based transportation solutions. Shifting freight and fuel transport to lower-carbon options, incentivizing efficient or alternative-fuel trucks, and expanding shared or community transit for residents could simultaneously cut emissions, improve safety, and reduce social isolation. For passenger vehicles, limited EV charging infrastructure must be paired with reliability-focused investments given the distances and terrain of the region.

### Electricity Generation Transition

Although hydroelectricity already provides a substantial portion of the area's power, petroleum remains a significant contributor to electricity-related emissions. Expanding hydro and integrating additional renewable generation—potentially solar microgrids or wind where feasible—could reduce dependence on petroleum. This would align with local resilience needs, particularly in communities facing high energy costs and unreliable fuel delivery. Coupling clean generation with efficiency programs would also ensure that savings reach households experiencing the highest cost burdens.

### Local Renewable Microgrids

Given the region's remoteness and vulnerability to extreme weather, deploying renewable-powered microgrids in smaller communities or facilities could reduce reliance on imported fuels while improving resilience. Solar paired with storage, or hybrid systems integrating wind or biomass, could stabilize power supply during disruptions and lower lifetime costs for residents. These systems also create opportunities for local workforce development in installation and maintenance.

### Community-Scale Energy Storage

High reliance on petroleum generation makes the grid vulnerable to fuel supply interruptions. Investing in battery storage or community-scale thermal storage could complement renewable generation by balancing demand, reducing peak fuel consumption, and ensuring reliability during outages. This approach supports both emissions reduction and resilience, particularly for critical facilities such as schools, clinics, and emergency shelters.

### Improved Outcomes for Overburdened and Underserved Communities

Improving outcomes for at-risk in this region requires that emissions reduction strategies are designed to reduce financial burdens while enhancing health and resilience. For low-income households, targeted weatherization, heating fuel-switching, and efficiency programs can directly lower utility bills and reduce reliance on costly imported fuels. By structuring programs with grants, subsidies, or on-bill financing, participation becomes accessible to those who might otherwise be excluded due to high upfront costs.

For residents with disabilities, improved outcomes come from ensuring universal accessibility in program design and implementation. This includes retrofitting housing with safe, efficient systems that improve indoor air quality, offering in-person program enrollment where internet access is limited, and ensuring adaptive transportation solutions. These approaches not only support emissions reduction but also improve quality of life for those most vulnerable to poor environmental conditions.

For communities of color and Indigenous residents, better outcomes depend on community-driven energy solutions that reinforce sovereignty and self-determination. Investments in tribal-led renewable energy projects, workforce development, and culturally relevant outreach ensure that emissions reduction strategies strengthen local capacity while delivering tangible economic and health benefits.

When implemented with equity at the center, mitigation strategies will not only reduce emissions but also deliver greater affordability, accessibility, and self-determination for residents—helping to close longstanding gaps in health, economic stability, and community wellbeing.

**Benefit (Disbenefit) Quantification or Qualitative Analysis****Residential & Commercial Heating Transition (weatherization + fuel-switch to heat pumps/biomass)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                        | Community Benefits                                                                                            |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Fuel-switching and envelope upgrades can cut space-heating emissions 25–50% per building; portfolio outcomes depend on uptake and housing stock suitability. | Prioritize low-income & substandard housing; largest % cuts where fuel oil dependence and drafts are highest. |
| Energy cost savings | High             | Weatherization + efficient systems can lower bills 20–40%; critical in region with 96th percentile energy burden.                                            | Direct affordability relief for low-income households struggling with high fuel bills.                        |
| Health benefits     | High             | Less indoor combustion and better ventilation/IAQ; warmer, drier homes reduce respiratory/ cardiovascular stress.                                            | Strongest benefits for disabled residents and elders vulnerable to poor IAQ.                                  |
| Resilience          | Moderate–High    | Weatherization protects homes during cold snaps; dual systems (backup heat) provide redundancy.                                                              | Improves safety for medically fragile residents in outages.                                                   |
| Disbenefits / risks | Low–Moderate     | Upfront costs, contractor shortages, and cold-climate heat pump performance challenges.                                                                      | Risk of exclusion if subsidies and hands-on enrollment are not provided.                                      |

**Transportation System Improvements (heavy-duty focus, efficiency + alt-fuel/electric; community transit)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                    | Community Benefits                                                                                                 |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Trucks account for 80%+ of transport emissions; efficiency and electrification could cut 30–60%.                                                         | Reduces freight costs/price pass-through on essentials; improves air near homes and community hubs.                |
| Energy cost savings | Moderate–High    | Vehicle O&M savings can be significant; fuel savings vary with diesel price and charging logistics; community transit reduces household transport spend. | Benefits households with limited car access; improves access to jobs, school, and care.                            |
| Health benefits     | High             | Lower diesel PM/NOx near stops, schools, and housing; traffic-safety co-benefits with safer fleets and transit.                                          | Strong benefits for children, elders, and communities located near road corridors.                                 |
| Resilience          | Moderate         | Diversifies away from diesel supply shocks; requires charging c and cold-weather readiness.                                                              | Reliable access for disabled residents via demand-response/ community transit.                                     |
| Disbenefits / risks | Moderate         | High capital costs; charging/ fueling infrastructure gaps; range/ performance penalties in extreme cold; workforce upskilling needed.                    | Risk of uneven service without equity routes/fares; ensure wheelchair-accessible vehicles and inclusive schedules. |

**Electricity Generation Transition (more hydro/renewables; displace petroleum)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                      | Community Benefits                                                                                             |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Replacing diesel gen-sets with hydro/solar/wind can cut generation emissions 40–80% depending on resource and penetration. | Lowers community-wide emissions without requiring household action—good for hard-to-reach at-risk communities. |
| Energy cost savings | Moderate–High    | Stabilizes costs against volatile diesel; potential for lower tariffs if savings passed through.                           | Can reduce burdens for households facing extreme energy costs.                                                 |
| Health benefits     | Moderate         | Less local combustion, noise, and spill risk; indoor benefits indirect.                                                    | Community-level benefits accrue universally; ensure siting avoids disproportionate impacts.                    |
| Resilience          | High             | Less dependence on fuel deliveries; diversified local supply; improved reliability with storage/hybridization.             | Stabilizes power for medical devices and essential services used by disabled/elderly residents.                |
| Disbenefits / risks | Low–Moderate     | High upfront capital, seasonal variability in hydro/solar/wind.                                                            | Must ensure affordability protections for low-income households during transition.                             |

**Local Renewable Microgrids (village/critical-facility microgrids with storage)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                       | Community Benefits                                                                     |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Diesel run-time reductions of 30–70% achievable with hybrid microgrids.                                     | Reductions concentrated in smaller, isolated communities.                              |
| Energy cost savings | Moderate–High    | Cuts fuel use and logistics costs; lowers outage costs for facilities; savings vary with system scale.      | Protects critical services (healthcare, shelters) that at-risk residents rely on most. |
| Health benefits     | Moderate         | Fewer local emissions/noise near gensets; continuity for refrigeration of meds and medical equipment.       | Directly benefits medically vulnerable residents during disturbances.                  |
| Resilience          | High             | Islanding during storms, faster recovery; black-start capability; protects communications and heat at hubs. | Reduces outage harms for those needing continuous power (disability/elder care).       |
| Disbenefits / risks | Low–Moderate     | Capital cost; O&M/controls expertise; battery end-of-life planning.                                         | Risk if siting or ownership excludes local/tribal leadership.                          |

**Community-Scale Energy Storage (batteries or thermal storage at grid/facility level)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                             | Community Benefits                                                                    |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Enables higher renewable penetration; curtails diesel start/stop; system-level CO <sub>2</sub> cuts 10–30% depending on dispatch. | Benefits are system-wide—good where individual households can't invest.               |
| Energy cost savings | Moderate         | Peak-shaving and diesel optimization reduce fuel and maintenance costs; facility-level thermal storage lowers heating fuel use.   | If designed well, savings can reduce burdens for low-income ratepayers.               |
| Health benefits     | Low–Moderate     | Indirect—less diesel cycling, fewer outages; facility thermal storage improves indoor comfort.                                    | Helps maintain safe temperatures for elders/disabled during peak events.              |
| Resilience          | High             | Backup for clinics, schools, and shelters during disruptions.                                                                     | Strong benefit for disabled and elderly who rely on emergency services.               |
| Disbenefits / risks | Low–Moderate     | Capital costs; siting, safety, and end-of-life concerns; requires skilled operations.                                             | Ensure safety standards and community input to avoid disproportionate siting burdens. |

**Cross-Cutting Community Benefits and Disbenefits**

Across all strategies, benefits for community benefits include:

- **Affordability:** Reduced energy bills from efficiency, renewables, and weatherization directly relieve household financial stress.
- **Health Improvements:** Lower exposure to indoor/outdoor air pollution benefits those with chronic conditions and disabilities.
- **Resilience:** Microgrids, storage, and improved housing protect vulnerable residents during outages or extreme weather.
- **Accessibility:** Community-based transportation and local energy solutions improve access to essential services, particularly for households without reliable vehicles or internet.
- **Equity in Participation:** Grants, subsidies, and community-led programs ensure that historically excluded groups share in benefits.

Potential disbenefits if not designed equitably:

- **Cost Barriers:** Without subsidies or flexible financing, upfront expenses risk excluding low-income households.
- **Program Accessibility:** Complex enrollment, online-only systems, or inaccessible technologies could leave disabled or digitally disconnected residents behind.
- **Uneven Benefits:** Savings and resilience gains may concentrate in better-off households unless targeted measures reach at-risk communities.
- **Cultural and Siting Impacts:** Renewable infrastructure siting could conflict with cultural or subsistence priorities if not community-led.
- **Reliability Concerns:** Heat pump performance, EV range, or renewable variability in extreme cold could create inequities if not paired with backup systems.

## Path Forward

For Copper River, the path forward lies in aligning emission reduction with equity and resilience. The analysis highlights heating transition, transportation improvements, and renewable generation as the highest-value strategies, both environmentally and socially. Local renewable microgrids and storage complement these efforts by enhancing resilience against extreme weather and supply chain vulnerabilities.

To ensure success, next steps should include:

- **Community Engagement:** Partner with tribal councils, schools, and local institutions to co-design solutions.
- **Equitable Financing:** Create grant and subsidy pathways that remove upfront cost barriers for low-income households.
- **Capacity Building:** Invest in local workforce training for renewable energy, weatherization, and system maintenance.
- **Monitoring & Accountability:** Track progress not only on emissions reduction but also on energy burden, health outcomes, and service access for at-risk residents.

By following this path, Copper River can advance a sustainability roadmap that reduces emissions, lowers costs, improves health, and enhances resilience—ensuring that the benefits of emissions reductions are shared across all communities in the region.



Mentasta Mountains: By Dave Bezaire & Susi Havens-Bezaires, wikimedia



# Denali Borough

Population: 1,613  
 Census Tract: 2068000100  
 Communities: Anderson, Cantwell, Denali Park, Ferry, Healy

Denali Borough faces a unique intersection of environmental, health, and socioeconomic challenges that shape how emissions reduction strategies will impact its residents. While the region's emissions are heavily concentrated in industrial stationary combustion, the community itself experiences disproportionately high energy burdens, significant disability prevalence, and elevated poverty rates. These conditions underscore the importance of ensuring that sustainability actions do more than reduce emissions—they must also address the lived realities of at-risk communities.

This roadmap identifies and evaluates strategies across industrial energy use, power generation, transportation, and housing efficiency. Each strategy is assessed not only for its potential to reduce emissions but also for its implications for health, affordability, and resilience. By centering fair outcomes, the analysis highlights pathways where sustainability action can simultaneously advance equity, improve community well-being, and build long-term resilience to both economic and environmental shocks.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Industrial & Stationary Combustion Reduction
2. Building Efficiency and Housing Resilience
3. Power Sector Decarbonization

The three most impactful strategies are Industrial & Stationary Combustion Reduction, Building Efficiency and Housing Resilience, and Power Sector Decarbonization. Industrial reductions matter most because they target the bulk of emissions, while building efficiency provides immediate relief for households facing high energy burdens and poor housing quality. Power sector decarbonization, though a smaller emissions source, enables long-term affordability and clean electrification, ensuring vulnerable communities benefit from a more resilient, lower-cost energy system.

## Emissions Data Overview

Total Emissions: Approximately 609,000 metric tons CO<sub>2</sub>-equivalent (mt CO<sub>2</sub>e).

### Stationary Combustion (95%)

- Residential Sector (1.12%)
  - Residential Fuel Oil No. 5: for 6,137.63 mt CO<sub>2</sub>e (1.01% of total emissions).
  - Electricity: 607.46 mt CO<sub>2</sub>e (0.1%).
  - Propane: 17.86 mt CO<sub>2</sub>e (negligible).
  - Wood/Wood Residuals: negligible at 38.85 mt CO<sub>2</sub>e (0.01%).
- Commercial Sector (2.36%)
  - Bituminous Coal: 10,847.43 mt CO<sub>2</sub>e (1.78%).
  - Distillate Fuel Oil No. 1: 3,250.16 mt CO<sub>2</sub>e (0.22%).
  - Propane: 103.07 mt CO<sub>2</sub>e (0.02%).
  - Electricity: 2,067.21 mt CO<sub>2</sub>e (0.34%).
  - Wood/Wood Residuals: 3.75 mt CO<sub>2</sub>e (negligible).
- Industrial Sector (91.46%)
  - Distillate Fuel Oil No. 1: 10,044.33 mt CO<sub>2</sub>e (1.65%).
  - Lignite Coal: 546,913.26 mt CO<sub>2</sub>e (89.81%).

### Transportation (5.06%)

- Fuel Type:
  - Motor Gasoline (main contributor): 22,368.31 mt CO<sub>2</sub>e (3.67%).
  - Diesel Fuel: 8,464.73 mt CO<sub>2</sub>e (1.39%).
  - Electricity (vehicles): 0.62 mt CO<sub>2</sub>e (negligible).
- In terms of vehicle types:
  - Trucks account for the majority—27,253.65 mt CO<sub>2</sub>e (88.39% of the transportation sector).
  - Passenger vehicles: 3,521.17 mt CO<sub>2</sub>e (11.42%).
  - Motorcycles: 58.84 mt CO<sub>2</sub>e (0.19%).

### Electricity Generation

- Total electricity consumption: 9,960 MWh.
  - Coal: 2,788.80 MWh, 893.25 mt CO<sub>2</sub>e (33.39%)
  - Petroleum: 5,478 MWh, 1,577.66 mt CO<sub>2</sub>e (58.97%)
  - Natural Gas: 996 MWh, 204.38 mt CO<sub>2</sub>e (7.64%)
  - Wind (298.8 MWh) and Hydro (398.4 MWh): zero direct CO<sub>2</sub>e emissions.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- The emissions profile is overwhelmingly dominated by industrial fuel use, which drives the bulk of stationary combustion emissions.
- Coal remains entrenched in electricity generation, adding significant carbon intensity despite relatively low overall consumption volumes.
- Residential and commercial emissions are relatively minor, indicating that household and small business energy use is not a primary driver. Although not included in the emissions inventory, there are residential households in the Denali Borough that burn coal for heat.
- Transportation is a secondary contributor, but freight and heavy truck use dominate, highlighting the importance of goods movement in the region.
- Petroleum and coal are significant in electricity generation, making the grid both carbon-intensive and vulnerable to fossil fuel price fluctuations.

**Implication:** Denali Borough's emissions are highly concentrated in large-scale fuel combustion, particularly within industrial and power generation activities. Meaningful emissions reduction will require engaging with industrial energy systems and the electricity mix, while also addressing the heavy reliance on trucking in transportation.

## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Vulnerability:** Anticipated changes in extreme weather are measured at 17.61, which suggests a moderate but growing exposure to extreme natural hazard events.
- **Disaster Losses:** With an annualized disaster loss of \$1.64 million and ranking in the 70th percentile nationally, Denali Borough is relatively vulnerable to costly environmental disruptions.
- **Pollution Exposure:** Diesel particulate matter exposure is negligible (0.00), and toxic releases are low (2nd percentile nationally). Air toxics cancer risk, however, stands at 8.00, indicating some exposure risks.
- **Hazardous Proximity:** Proximity to hazardous waste, sites, and facilities remains generally low, suggesting limited industrial contamination concerns.
- **Housing Age and Infrastructure:** About 28% of housing predates 1980, raising concerns about older infrastructure quality. However, only 3% predates 1960, which lowers risks of the most outdated structures.

**Implication:** Denali Borough experiences moderate environmental vulnerabilities from extreme weather and costly disaster potential, but low pollution and hazard site exposure. This balance suggests community resilience planning should prioritize adaptation to weather extremes and infrastructure age rather than remediation of pollution hotspots.

### Public Health Indicators

- **Chronic Disease Burden:** Asthma (1.85%), diabetes (1.67%), and cancer (1.13%) prevalence are all lower than national averages, but high blood pressure (6.32%) is slightly higher.
- **Mental Health:** Poor mental health prevalence (2.41%) is relatively low compared to national rates, but still indicates a share of the community faces mental health challenges.
- **Heart Disease:** At the 41st national percentile, heart disease risk is moderate.
- **Life Expectancy:** Data on life expectancy is not available, but reported low percentile scores (0.00) suggest potential data gaps.

**Implication:** The community is not heavily burdened by chronic diseases, though cardiovascular and mental health needs should not be overlooked. This relatively healthy baseline could support resilience, but environmental stressors (e.g., extreme weather, isolation) may disproportionately affect vulnerable residents.

### Socioeconomic Factors

- **Poverty:** About 30% of the population lives below 200% of the federal poverty line, ranking high (72nd percentile nationally).
- **Education:** Only 2.3% lack a high school diploma, reflecting strong educational attainment.
- **Unemployment:** At 2.7%, unemployment is relatively low, but income inequality (GINI index of 0.39) shows uneven distribution.
- **Housing and Insurance:** Renter occupancy is 17%, while 12.9% of residents are uninsured, suggesting some gaps in housing and healthcare stability.
- **Access Barriers:** Nearly 15% lack internet access, and energy burden is high (4.0, 86th percentile nationally), reflecting both digital and energy inequities.
- **Vulnerable Groups:** Disability prevalence (16.3%, 79th percentile) and reliance on mobile homes (7.8%, 82nd percentile) highlight significant vulnerability factors.

**Implication:** Denali Borough's socioeconomic profile is marked by poverty, high energy burden, disability prevalence, and infrastructure vulnerabilities. These inequities mean that emissions reduction efforts must be designed to reduce, rather than exacerbate, household cost and access burdens.

### Transportation Insecurity

- **Access:** The transportation access score is extremely low (0.58), placing the community in the 86th percentile nationally for transportation insecurity.
- **Cost Burden:** Transportation cost burden is moderate (0.13), showing affordability issues are present but not the most acute challenge.
- **Safety:** Traffic safety fatalities are high (7.62 per 100,000), placing Denali Borough in the 91st national percentile—highlighting substantial risk in roadway travel.

**Implication:** Transportation insecurity is one of the most significant determinants in Denali Borough. Limited access, combined with high fatality risk, indicates transportation is both a logistical and safety concern, especially in rural, remote, and environment-sensitive conditions.

### Intersection with Emissions Reduction Planning

Denali Borough's social determinants of health present both resilience factors and vulnerabilities that will directly influence emissions reduction planning:

- **Equity Concerns:** High poverty rates, energy burden, and disability prevalence mean pollution reduction strategies must consider affordability and accessibility to prevent worsening inequities.
- **Infrastructure Gaps:** Older housing stock, limited internet access, and mobile home reliance may constrain the community's ability to adopt clean technologies or efficiency upgrades without support.
- **Health and Safety:** While baseline health outcomes are relatively favorable, high rates of hypertension, disability, and transportation fatalities suggest that pollution reduction policies should incorporate co-benefits like safer mobility and improved air quality.
- **Geographic Resilience:** Low current pollution and hazard exposure reduce remediation needs, allowing a stronger focus on adaptation, energy efficiency, and cost-reduction in local sustainability initiatives.
- **Community Context:** Rural and remote conditions amplify transportation and energy challenges, meaning emissions reduction solutions must address geographic isolation as a driver of both emissions and inequities.

## Mitigation Strategies

### Industrial and Stationary Combustion Reduction

Denali Borough's emissions profile is dominated by stationary combustion, with industrial activity accounting for more than 90 percent of the total. Addressing this sector will be essential for any meaningful reduction. Shifting industrial operations away from petroleum and coal toward lower-carbon fuels such as renewable diesel, natural gas as a transitional option, or eventually electrification will create the largest impact. Investments in combined heat and power systems, particularly those that harness renewable resources or capture waste heat, could reduce emissions while improving efficiency. Equally important are efficiency upgrades across large facilities, which can lower fuel consumption without compromising productivity. Beyond environmental benefits, reducing reliance on fossil fuels can stabilize operational costs and reduce toxic exposures, indirectly supporting healthier living conditions in surrounding communities.

### Power Sector Decarbonization

While electricity generation represents less than one percent of Denali's total emissions, the fuel mix is heavily reliant on coal and petroleum. This reliance keeps the grid carbon-intensive and vulnerable to volatile fossil fuel prices. Replacing these fuels with renewable energy resources—wind, hydro, or solar combined with storage—offers an opportunity to shift the region's power supply toward cleaner and more stable sources. Microgrids anchored in schools, public buildings, and civic centers could provide reliable power while serving as resilience hubs during outages or extreme weather events. These efforts not only reduce emissions but also address Denali's high energy burden, easing household costs and supporting vulnerable residents who are most affected by disruptions in energy supply.



### Transportation and Freight Emissions

Transportation is a smaller share of the overall emissions profile at around five percent, yet it presents clear opportunities for intervention. Freight and heavy-duty trucks account for nearly ninety percent of transportation emissions, making this the critical target for decarbonization. Transitioning freight fleets toward electric vehicles or renewable diesel would reduce emissions while also lowering local air pollution. Safety concerns are equally pressing: Denali Borough ranks in the highest percentiles for traffic fatalities nationwide, highlighting the need for roadway improvements such as better lighting, signage, and design features. Expanding regional transit coordination can also ease access challenges for low-income residents who face transportation insecurity. Together, these measures can reduce emissions, improve safety, and create more equitable mobility options.

### Building Efficiency and Housing Resilience

Housing conditions in Denali reflect significant vulnerabilities, with a high reliance on mobile homes, older housing stock, and households facing an outsized energy burden. Expanding weatherization and energy efficiency retrofits is a practical way to address these issues, particularly for low-income residents. Incentives for efficient heating systems such as heat pumps, or renewable heating alternatives, could substantially reduce household energy costs while improving comfort and indoor air quality. Given the overlap between housing challenges and poverty, linking retrofit initiatives to local workforce development in construction and clean energy would build economic opportunity alongside emissions reduction. In this way, housing-focused strategies directly improve quality of life while supporting emissions reduction goals.

### Improved Outcomes for Overburdened and Underserved Communities

Mitigation strategies in Denali Borough have the potential to deliver significant benefits for limited income, disabled, and other at-risk populations. Reducing dependence on petroleum and coal through industrial and power sector reform can ease cost pressures that disproportionately burden households already struggling with high utility bills. For low-income residents, who experience one of the highest energy burdens nationally, this translates into more stable monthly expenses and improved housing affordability.

Disabled residents stand to benefit directly from housing retrofits and energy system improvements, as weatherization and cleaner heating systems enhance indoor comfort, reduce respiratory stress, and ensure safer living environments. Improved transportation safety and access are also critical for people with disabilities, who face higher risks when infrastructure is inadequate or hazardous. By integrating decarbonization with roadway safety measures, Denali can both lower emissions and protect its most vulnerable travelers.

For at-risk groups more broadly, resilience measures tied to energy and transportation—such as microgrids for public facilities and safer freight corridors—can reduce the health and safety impacts of extreme weather, power outages, and mobility challenges. In this way, sustainability action becomes not only an environmental priority but also a tool for advancing social equity, ensuring that Denali's transition to a low-carbon future delivers tangible improvements in health, safety, and economic security for those most in need.





**Benefit (Disbenefit) Quantification or Qualitative Analysis****Industrial & Stationary Combustion Reduction**

| Outcome             | Potential Impact                        | Quantitative / Qualitative Assessment                                                                                                                                            | Community Benefits                                                                                                         |
|---------------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High                                    | Stationary combustion accounts for ~95% of emissions, with industrial operations driving the majority. Large cuts possible if major fuel-switching or efficiency upgrades occur. | Indirect but major benefits: system-wide reductions support households facing poverty, disability, and high energy burden. |
| Energy cost savings | High (industrial); Moderate (household) | Lower fuel costs and volatility for operators; indirect benefits for households if savings stabilize rates or local budgets.                                                     | Helps reduce financial stress for low-income and high-burden households by preventing pass-through cost spikes.            |
| Health benefits     | Moderate–High                           | Reduces co-pollutants (NO <sub>x</sub> , SO <sub>2</sub> , PM) from petroleum and coal combustion.                                                                               | Supports residents with cardiovascular conditions and disabilities, improving baseline health resilience.                  |
| Resilience          | High                                    | Efficiency and combined heat and power improve reliability and reduce exposure to fuel supply disruptions.                                                                       | Critical during outages and extreme weather, especially for vulnerable groups dependent on reliable energy.                |
| Disbenefits / risks | Moderate                                | High capital costs, fuel supply limits, and workforce needs may slow transition.                                                                                                 | Risk of rate increases or job loss if costs aren't managed equitably; must protect limited-income households.              |

**Power Sector Decarbonization**

| Outcome             | Potential Impact         | Quantitative / Qualitative Assessment                                                                                                    | Community Benefits                                                                                       |
|---------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate                 | Electricity is <1% of emissions, but heavy reliance on coal and petroleum makes decarbonization impactful for long-term electrification. | Creates a clean power baseline for households to adopt electrified heating and appliances affordably.    |
| Energy cost savings | Moderate–High (long-run) | Replacing fossil fuels with renewables reduces volatility and avoids expensive fuel transport.                                           | Directly relieves energy-burdened households and renters, improving affordability and access.            |
| Health benefits     | Moderate                 | Cleaner generation reduces air pollutants; electrification reduces indoor exposure to combustion heating.                                | Significant improvements for residents in older/mobile housing and those with chronic health conditions. |
| Resilience          | High                     | Microgrids and storage at schools and public facilities ensure backup power and reduce reliance on fuel deliveries.                      | Provides critical protection for seniors, disabled residents, and low-income families during outages.    |
| Disbenefits / risks | Low–Moderate             | Upfront costs and grid integration challenges; equity risk if rates shift disproportionately.                                            | Safeguards needed to ensure affordability and fair distribution of benefits for vulnerable groups.       |

### Transportation & Freight Emissions

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                              | Community Benefits                                                                                                    |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Transportation contributes ~5% of emissions; heavy-duty trucks drive nearly 90% of this share. Fleet transition offers most gains. | Reduces diesel exposure along routes near low-income or worker-heavy areas.                                           |
| Energy cost savings | Moderate         | Electrified or more efficient fleets save on fuel over time; household fuel savings smaller due to low passenger share.            | Access improvements reduce time and cost burdens for households with limited transportation options.                  |
| Health benefits     | High             | Roadway safety is a major issue with very high fatality rates; addressing safety provides immediate health benefits.               | Safer roads and cleaner air directly benefit low-income and disabled residents who rely on limited transport options. |
| Resilience          | Moderate         | Improved freight efficiency secures supply chains for food, fuel, and medicine during disruptions.                                 | Helps at-risk populations maintain access to essentials during crises.                                                |
| Disbenefits / risks | Low–Moderate     | High costs for vehicle and infrastructure upgrades; freight cost passthroughs possible.                                            | Must prevent regressive fare or freight price increases that could burden low-income households.                      |



**Building Efficiency and Housing Resilience**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                           | Community Benefits                                                                                                                                  |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate     | Residential/commercial combustion is a small share of total emissions (~3%). Retrofits and clean heating upgrades reduce emissions but not at the scale of industrial or freight interventions. | Though emissions reductions are modest, direct household-level improvements matter most for vulnerable residents in older or mobile housing.        |
| Energy cost savings | High             | Weatherization, insulation, and heat pumps reduce heating fuel use substantially in cold climates. With an energy burden in the 86th percentile, even modest savings make a large difference.   | Direct relief for limited-income households, renters, and seniors who face high heating costs and limited disposable income.                        |
| Health benefits     | High             | Efficiency upgrades improve indoor air quality and reduce respiratory stress from combustion-based heating. Warmer, safer homes lower risks of cold-related illness.                            | Particularly valuable for residents with chronic conditions (e.g., heart disease, asthma) and people with disabilities who spend more time indoors. |
| Resilience          | Moderate–High    | Upgraded housing stock is better able to withstand extreme cold, power outages, and weather events. Retrofits extend asset life and reduce maintenance costs.                                   | Improves housing security for low-income residents, especially in mobile homes, reducing displacement risks in harsh conditions.                    |
| Disbenefits / risks | Low–Moderate     | Upfront retrofit costs are significant; renters may not directly benefit if landlords capture incentives. Program design must avoid leaving out those without capital or credit.                | Risk of inequity if programs don't specifically target low-income or mobile-home residents; subsidies and renter protections are essential.         |

**Cross-Cutting Community Benefits and Disbenefits**

Across all strategies, benefits for community benefits include:

- Lower household energy costs, reducing burdens on limited-income families.
- Improved indoor air quality and healthier housing conditions for residents with chronic conditions and disabilities.
- Greater resilience during outages and extreme weather through efficiency, microgrids, and safer housing.
- Enhanced transportation safety and access, lowering risks for residents with limited mobility or resources.
- Economic opportunities through local jobs in retrofits, clean energy, and infrastructure upgrades.
- Potential disbenefits if not designed equitably:
  - Upfront costs could be passed through to consumers if not managed with subsidies or protections.
  - Risk of leaving out renters or mobile-home residents if programs focus only on property owners.
  - Infrastructure transition challenges (grid upgrades, charging stations, workforce capacity) could slow benefits.
- Possibility of uneven access if digital and geographic barriers aren't addressed.

## Path Forward

Denali Borough's emissions profile and social determinants of health make clear that sustainability measures cannot be separated from community well-being. The greatest emissions reductions will come from addressing industrial stationary combustion, while the most immediate household benefits lie in building efficiency and housing resilience. Power sector decarbonization, though a smaller share of current emissions, will lay the groundwork for long-term affordability and reliable access to clean energy. Taken together, these strategies provide a balanced approach that tackles both systemic emissions drivers and day-to-day burdens for vulnerable residents.

Moving forward, the path for Denali should prioritize equity-centered implementation. Programs must be designed to reduce costs for limited-income households, protect renters and mobile-home residents, and ensure that people with disabilities and chronic health conditions are not left behind. At the same time, industrial and energy transitions will require strong partnerships with major operators, workforce development to build local capacity, and financing mechanisms that prevent the shifting of costs onto already burdened communities.

By focusing on solutions that cut emissions while improving health, resilience, and affordability, Denali Borough can lead by example in integrating emissions reduction actions with social equity. The strategies outlined here form the foundation for a practical, community-centered path forward—one that reduces emissions, strengthens resilience, and delivers tangible benefits to those who need them most.





# Western Bristol Bay, Dillingham Census Area

Population: 2,318

Census Tract: 2070000100

Communities: Aleknagik, Clark's Point, Ekwok, Koliganek, Manokotak, New Stuyahok, Portage Creek, Togiak, Twin Hills

Western Bristol Bay, located within the Dillingham Census Area of Alaska, faces a unique intersection of environmental, health, and socioeconomic challenges that shape both its current conditions and its path toward a lower-carbon future. The region's residents experience some of the highest poverty and energy burdens in the nation, alongside significant transportation insecurity and limited digital access. At the same time, the area demonstrates remarkable community resilience, reflected in strong longevity outcomes and a deep reliance on traditional practices and social cohesion.

The emissions profile of the region is dominated by petroleum use—residual fuel oil for home heating, diesel generation for electricity, and heavy-duty vehicles for freight and supply chains. These systems are not only the largest sources of air pollutants but also impose steep costs on households and public services, reinforcing cycles of economic strain and health vulnerability. Elevated rates of chronic illness, asthma, and poor mental health intensify the stakes, as pollution and high energy costs directly affect health and quality of life.

This roadmap builds on these realities by aligning mitigation strategies with the needs of at-risk communities. The goal is to highlight interventions that reduce emissions while also delivering tangible benefits in affordability, health, resilience, and equity. By grounding sustainability actions in the lived conditions of Western Bristol Bay, the region can advance an emissions reduction plan that not only cuts emissions but also improves daily life for those who bear the greatest burdens.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Building Energy & Housing Upgrades
2. Electricity Transition to Renewables & Microgrids
3. Transportation & Mobility Efficiency (Freight + Public Fleets)

**Overall:** These three strategies are most impactful because they align emissions reductions with direct improvements in affordability, health, and resilience, ensuring that vulnerable communities—those facing the greatest burdens—are also the first to benefit.



## Emissions Data Overview

Note that these data are for the entire Census Area, which includes two Census Tracts.

Total Modeled Emissions: 39,942 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (66.15%)

- Residential Sector (48.05%)
  - Residual Fuel Oil No. 5: 16,683.8 mt CO<sub>2</sub>e (41.77% of total emissions).
  - Electricity: 2,316.63 mt CO<sub>2</sub>e (5.8%).
  - Natural Gas: 103.99 mt CO<sub>2</sub>e (0.26%).
  - Propane: 53.58 mt CO<sub>2</sub>e (0.13%).
  - Wood/Wood Residuals: 32.43 mt CO<sub>2</sub>e (0.08%).
- Commercial Sector (24.22%)
  - Distillate Fuel Oil No. 1: 4,306.6 mt CO<sub>2</sub>e (10.78%).
  - Propane: 328.76 mt CO<sub>2</sub>e (0.82%).
  - Electricity: 5,025.76 mt CO<sub>2</sub>e (12.58%).
  - Wood/Wood Residuals: 11.95 mt CO<sub>2</sub>e (0.03%).
- Industrial Sector: 0%. No direct emissions from industrial combustion processes were reported.

### Transportation (27.74% of total emissions)

- Fuel types:
  - Motor Gasoline: ~9,072 mt CO<sub>2</sub>e
  - Diesel Fuel: ~2,006 mt CO<sub>2</sub>e
  - Electricity: negligible (~0.08 mt CO<sub>2</sub>e)
- Vehicle types:
  - Trucks: ~10,152 mt CO<sub>2</sub>e (≈ 92% of transport emissions)
  - Passenger vehicles: ~911 mt CO<sub>2</sub>e (≈ 8%)
  - Motorcycles: ~15 mt CO<sub>2</sub>e

### Electricity Generation

- Electricity usage: 25,495 MWh
- Fuel source: 100% petroleum-based
- Emissions: ~7,342 mt CO<sub>2</sub>e

All electricity is generated from petroleum, reflecting a lack of renewable or grid-connected alternatives.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- The region's emissions profile is overwhelmingly shaped by building heating fuel use and electricity generation, both heavily dependent on petroleum.
- Residual fuel oil No. 5 is a central emissions source in residential heating.
- Transportation emissions are significant, with heavy trucks as the main driver.
- Lack of renewable power options underscores reliance on imported or locally burned fossil fuels.

## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Risk:** Anticipated changes score of 3.98 indicates modest but notable vulnerability to extreme natural hazard events.
- **Disaster Loss:** Annualized losses are relatively low at \$233,442.44, but this represents a 13.64th percentile nationally, suggesting exposure is not negligible.
- **Air Quality:** Diesel particulate exposure is 0.00, yet air toxics cancer risk is at the 8th percentile nationally, indicating low but present risks.
- **Hazardous Sites:** No Superfund sites or hazardous waste sites nearby. However, Risk Management Plan (RMP) facility proximity is at the 68th percentile, implying possible localized industrial risks.
- **Housing Age:** 36.87% pre-1980 housing (48.86th percentile), suggesting some stock may be less energy efficient.
- **Flood Risk:** 3% of properties at risk (23rd percentile nationally), representing a modest but important exposure.

**Implications:** While the region does not carry the same environmental burdens as more industrialized areas, vulnerabilities to extreme weather, older housing stock, and localized industrial facility risks remain relevant. These conditions mean that resilience strategies must emphasize infrastructure safety and modernization, particularly as environmental stressors intensify.

### Public Health Indicators

- **Chronic Illness:** Diabetes prevalence (6.61%, 72nd percentile) and high blood pressure (17.75%, 59th percentile) are elevated.
- **Respiratory & Mental Health:** Asthma (6.21%, 63rd percentile) and poor mental health prevalence (8.73%, 63rd percentile) are above average.
- **Cardiovascular Disease:** Heart disease burden is very high (89th percentile nationally).
- **Cancer:** Lower at 2.42% prevalence, 44th percentile.
- **Life Expectancy:** Remarkably high at 86.5 years, in the 1st percentile for low expectancy, suggesting longevity despite chronic disease burdens.

**Implications:** Health outcomes reveal a paradox of both elevated chronic disease prevalence and exceptional life expectancy. This points to resilience in community health systems and traditional lifeways, but the high rate of chronic disease also increases vulnerability to environmental conditions and energy-related stressors, such as poor air quality, inconsistent heating, and limited access to healthcare resources.

### Socioeconomic Factors

- **Poverty:** 65.3% live below 200% Federal Poverty Level (FPL) (98th percentile nationally), showing very high economic precarity.
- **Education:** 16.4% lack a high school diploma (94th percentile).
- **Unemployment:** 9.1% (90th percentile), far above national averages.
- **Housing:** Median home value \$85,900 (11th percentile), reflecting low property wealth.
- **Uninsured:** 19.7% (84th percentile), signaling barriers to healthcare.
- **Digital Divide:** 42.1% lack internet access (97th percentile), a critical limitation for education, telehealth, and environmental adaptation resources.
- **Energy Burden:** Extremely high at 11% of household income (99th percentile nationally), underscoring affordability and sustainability challenges.
- **Demographics:** Younger population (30.8% under 17, 86th percentile) and notable elder population (12.6% over 65, 72nd percentile).

**Implications:** The socioeconomic landscape is characterized by high poverty, unemployment, and digital isolation, alongside extreme energy burden. These conditions highlight both the economic fragility of households and the urgency of equitable, cost-reducing energy interventions.

### Transportation Insecurity

- Access Score: 0.00, indicating severe lack of reliable transportation.
- Cost Burden: 0.21 of household income (96th percentile nationally), showing transportation is a disproportionately heavy expense.
- Traffic Safety: Fatalities at 4.36 per 100,000 (78th percentile), reflecting higher risks relative to national averages.

Implications: Transportation barriers compound socioeconomic and health inequities, limiting access to employment, healthcare, and other essential community resources. The cost and safety burdens underscore the need for mobility solutions that are both affordable and reliable.

### Intersection with Emissions Reduction Planning

The intersecting conditions of Western Bristol Bay present both constraints and opportunities for emissions reduction policy design:

- Economic Vulnerability: High poverty, unemployment, and energy burden mean households will struggle to adopt costly mitigation measures without targeted subsidies or support.
- Health Burdens: Elevated chronic illness increases sensitivity to air quality and energy insecurity impacts, making co-benefits from pollution reduction (e.g., cleaner air, reduced fuel reliance) particularly valuable.
- Infrastructure Gaps: Lack of internet and transportation access may limit community engagement in emissions reduction programs unless outreach strategies are tailored.
- Cultural Resilience: High life expectancy despite economic stress suggests community cohesion and traditional practices may be leveraged for adaptation and engagement in sustainable practices.

Overall: Western Bristol Bay's social determinants of health indicate that equity must be central to emissions reduction strategies. Solutions will need to alleviate energy and transportation burdens, strengthen health protections, and be tailored to reach a socioeconomically fragile yet resilient population.

## Mitigation Strategies

### Building Energy & Housing

The most significant driver of emissions is stationary combustion, particularly the heavy reliance on residual fuel oil No. 5 for residential heating. Given the extremely high energy burden (99th percentile nationally) and prevalence of older, less efficient housing stock, strategies that improve home energy efficiency and expand access to cleaner, lower-cost heating options will deliver the greatest impact. Weatherization programs, high-efficiency heat pumps, and renewable district heating solutions could lower both emissions and household costs. Because poverty and unemployment levels are high, programs should be structured with upfront assistance or subsidies so that households are not locked out of improvements. The result would be immediate relief to household budgets, reductions in pollution exposure, and measurable emissions cuts.

### Electricity Transition

Electricity in the region is generated entirely from petroleum fuels. This not only adds emissions but increases costs and energy insecurity. Transitioning toward renewable microgrids, community-scale wind and solar, or hydro where feasible could diversify energy supply and reduce dependency on imported petroleum. These investments align with the region's challenges—high energy burden and limited internet/digital connectivity—by offering locally controlled energy systems that are resilient and adaptable. Improved local generation also strengthens reliability for healthcare, schools, and essential services, reducing vulnerability in a region with notable chronic disease prevalence.

## Transportation & Mobility

Transportation emissions are dominated by trucks and heavy-duty vehicles, reflecting freight and supply movement essential to remote communities. At the same time, households experience a disproportionate transportation cost burden (96th percentile) with virtually no public transit infrastructure. Mitigation strategies should focus on fleet efficiency improvements, low-carbon fuels, and regional logistics optimization rather than expecting rapid electrification of personal vehicles, given infrastructure limitations. For residents, strategies like expanding community shuttle systems, incentivizing shared transport for essential trips, and developing charging or fueling infrastructure could gradually reduce emissions while directly lowering costs and improving access to services.

## Improved Outcomes for Overburdened and Underserved Communities

Implementing emissions reduction strategies in Western Bristol Bay offers opportunities for transformative improvements in outcomes for vulnerable and at-risk communities. The region's residents face disproportionately high poverty rates, extreme energy burden, transportation insecurity, and digital exclusion, alongside elevated rates of chronic illness. Addressing emissions and energy sources is not only an environmental priority but also a pathway to reducing inequities and improving community well-being.

- **Lower Household Energy Burden** - By reducing reliance on residual fuel oil No. 5 and petroleum-based electricity, households can experience significant relief from the region's 99th percentile energy burden. Weatherization, efficient heating technologies, and renewable microgrids will directly lower utility costs, freeing household income for food, healthcare, and education.
- **Health Improvements** - Transitioning away from diesel and fuel oil reduces exposure to air toxics and combustion byproducts that contribute to asthma, heart disease, and poor mental health—conditions already elevated in the area. Cleaner air and more stable indoor heating environments improve long-term health outcomes and reduce healthcare costs, particularly for elders and children who are most vulnerable.
- **Enhanced Mobility and Access** - Transportation costs are among the highest in the nation relative to income, and fatalities occur at disproportionately high rates. Investment in shared, safe, and low-emission transport options enhances access to healthcare, education, and employment, while reducing dependence on expensive fuels. This creates safer, more reliable pathways for community participation in regional life.
- **Economic and Workforce Benefits** - Mitigation strategies create pathways for local employment in renewable energy installation, building efficiency retrofits, and transportation system upgrades. These opportunities address the area's high unemployment rate and strengthen community capacity by developing local expertise, reducing reliance on external contractors, and keeping dollars in the region.
- **Resilient and Equitable Infrastructure** - Renewable energy systems, efficient homes, and safer transport infrastructure reduce vulnerability to extreme weather and energy price shocks. For communities with limited internet access and constrained resources, resilience measures ensure continuity of essential services—schools, clinics, and tribal governance—during disruptions.

In sum, emissions reduction in Western Bristol Bay will improve outcomes for at-risk communities by reducing financial strain, improving health, increasing safety and access, and creating economic opportunities. These strategies ensure that vulnerable households, which currently carry the heaviest burdens, are the first to benefit from emissions reduction investments, making equity central to the region's pollution reduction roadmap.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Building Energy & Housing (weatherization, envelope upgrades, efficient heating/HPs)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                                                | Community Benefits                                                                                                                                                         |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Stationary combustion is the region's largest source; residential oil heat is dominant. Typical deep weatherization can cut home energy use ~20–35%. If an average oil-heated home saves ~453 gal/year of fuel (a commonly documented WAP outcome), that's ~4.6–4.8 tCO <sub>2</sub> e/home-yr and scales quickly across households. | Directly lowers emissions where at-risk households spend the most (heating). Prioritizing low-income homes maximizes \$/tCO <sub>2</sub> e equity benefits.                |
| Energy cost savings | High             | Western/coastal heating fuel often ~\$7–\$8/gal. At ~453 gal saved, typical annual household savings ≈ \$3,200–\$3,600; plus 20–30% total bill reductions from envelope + controls.                                                                                                                                                  | Reduces the region's 99th-percentile energy burden, freeing income for essentials (food, meds, school costs). Protects elders and large families from winter price shocks. |
| Health benefits     | High             | Tighter/ventilated homes cut indoor PM and moisture/mold; cleaner heating lowers outdoor toxics. Co-benefits are largest where asthma, heart disease, and poor mental health are elevated.                                                                                                                                           | Health gains accrue most to at-risk elders, children, and high-burden households that currently face the worst indoor conditions and highest fuel use.                     |
| Resilience          | High             | Lower fuel use = fewer risky/expensive deliveries; weatherized homes ride out outages/price spikes better (slower heat loss).                                                                                                                                                                                                        | Improves sheltering in place, especially for households with limited transport access or medical needs.                                                                    |
| Disbenefits / risks | Moderate         | Up-front costs; contractor capacity; supply-chain delays; poor installs if QA/QC is thin; some homes need repairs before weatherization.                                                                                                                                                                                             | If not designed for equity (no-cost or heavy subsidy, concierge support), at-risk households can be left out. Workforce gaps can delay benefits in remote communities.     |



**Electricity Transition (renewable/displacing petroleum generation; microgrid upgrades)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                                                                                                       | Community Benefits                                                                                                                                                                    |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Local electricity is petroleum-based. Using the emissions overview, electricity contributes a meaningful share of total community CO <sub>2</sub> e. As a planning yardstick: each 10% displacement of petroleum power ≈ a 10% cut in electricity-sector CO <sub>2</sub> e (e.g., if electricity accounts for ~7,300 tCO <sub>2</sub> e/yr, then 10% → ~730 tCO <sub>2</sub> e/yr avoided). | Displacing diesel generation reduces both GHGs and local combustion byproducts near homes/schools/clinics—high co-benefit density for at-risk areas.                                  |
| Energy cost savings | Moderate–High    | Levelized costs for renewables in remote AK vary, but paired with controls/storage, they typically reduce fuel burn and price volatility. Savings are sensitive to financing, O&M, and resource quality.                                                                                                                                                                                    | Cuts electric bills and stabilizes costs where energy burden is extreme; benefits public services (clinics, water/wastewater, schools) used disproportionately by at-risk households. |
| Health benefits     | Moderate         | Fewer hours of diesel gen = less PM/NOx and less on-site fuel handling. Health gains are real but smaller than building-heat swaps because many combustion sources remain.                                                                                                                                                                                                                  | Improves air around community generators often sited near at-risk housing; supports telehealth reliability where connectivity exists.                                                 |
| Resilience          | High             | More local generation + storage reduces dependency on fuel deliveries and improves outage performance for critical facilities.                                                                                                                                                                                                                                                              | Keeps essential services online for at-risk residents during storms/aviation delays; protects food and medicines (cold chain).                                                        |
| Disbenefits / risks | Moderate         | Up-front capex; O&M requirements; intermittency; integration complexity; possible tariff impacts if not designed well; workforce for ops/maintenance.                                                                                                                                                                                                                                       | If tariffs shift to recover costs without shields, bills could rise. Equity guardrails (lifeline rates, PCE alignment, targeted subsidies) are essential.                             |



**Transportation & Mobility (freight/logistics efficiency, fleet upgrades, safer shared mobility)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                 | Community Benefits                                                                                                                                                               |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Transport is the #2 source; trucks/ HDVs dominate emissions. Practical near-term lever is efficiency + routing + low-carbon fuels. As an order-of-magnitude: 10% fuel-efficiency gain for the truck share can avoid roughly ~1,000 tCO <sub>2</sub> e/ yr (based on the overview of truck emissions). | Targeting freight lowers costs of goods essential to at-risk households; public fleets (school, health, municipal) can lead and deliver direct local air benefits.               |
| Energy cost savings | Moderate         | Freight/logistics efficiency and right-sizing reduce fuel spend across supply chains; pooled shuttles lower per-trip costs for residents with limited access.                                                                                                                                         | Reduces 96th-percentile transportation cost burden for low-income residents; better access to clinics, schools, and jobs.                                                        |
| Health benefits     | Moderate         | Fewer HDV hours/idling reduce roadside PM/NOx; safer shared mobility can lower traffic injuries/fatalities (already elevated).                                                                                                                                                                        | Benefits at-risk neighborhoods often closest to truck routes or with fewer safe mobility options; improves access to preventive care.                                            |
| Resilience          | Moderate         | More reliable/affordable mobility options (community shuttles, coordinated freight) improve continuity of services during weather disruptions.                                                                                                                                                        | Ensures access to clinics, food distribution, and schools when fuel is scarce or roads/air links are constrained.                                                                |
| Disbenefits / risks | Low–Moderate     | Rural EV charging gaps; cold-weather performance; capital costs for fleet turnover; change-management with carriers.                                                                                                                                                                                  | If designed around private EVs first, at-risk residents may see little benefit; program should prioritize shared/essential services and freight corridors serving at-risk areas. |



### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy costs through reduced fuel use and improved efficiency.
- Improved indoor and outdoor air quality, reducing asthma, heart disease, and mental health stressors.
- More resilient homes and services, better able to withstand outages, extreme weather, and fuel delivery delays.
- Greater access to mobility for healthcare, schools, and jobs via safer, more affordable transport options.
- Local job creation in energy retrofits, renewable installation, and fleet services, supporting economic stability.
- Enhanced equity in program design when subsidies, lifeline rates, and non-digital outreach make programs accessible to low-income households.

Potential disbenefits if not designed equitably:

- High upfront costs for technologies may exclude at-risk residents if programs aren't fully subsidized.
- Tariff shifts or cost recovery in utility rates could raise bills without equity safeguards.
- Capacity and workforce limits could slow delivery in rural/remote settings, delaying benefits.
- Digital access barriers may prevent households without internet from enrolling or benefiting.
- Risk of inequitable rollout if programs prioritize private or higher-income users before shared or essential services.

### Path Forward

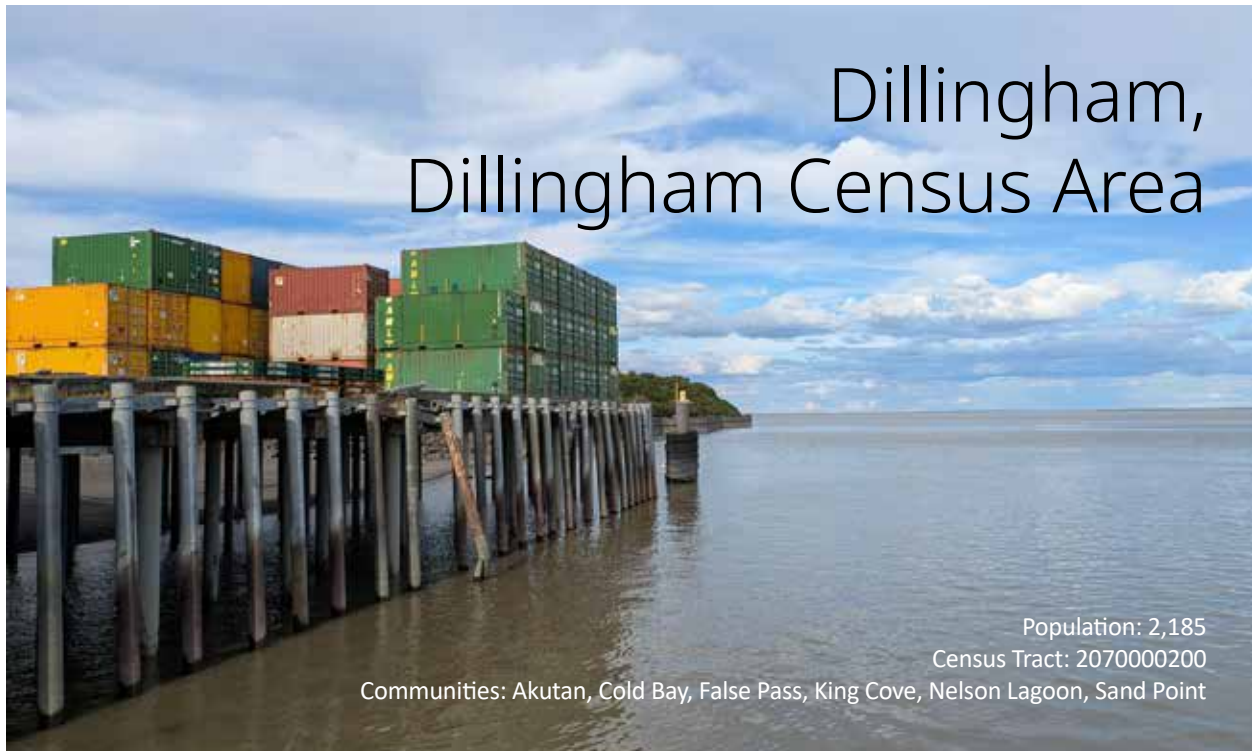
Western Bristol Bay's pathway to emissions reduction is both urgent and full of opportunity. The region's reliance on petroleum fuels for heating, electricity, and transportation makes it especially vulnerable to high costs, health burdens, and supply chain disruptions. At the same time, the data reveal a community with deep resilience and the potential to benefit substantially from targeted mitigation strategies.

The analysis highlights three priority areas for action: improving building efficiency and heating systems, transitioning electricity to renewable and resilient microgrids, and advancing transportation efficiency through freight and shared mobility solutions. Together, these strategies address the region's largest emission sources while simultaneously reducing household costs, improving public health, and strengthening resilience against extreme weather and energy insecurity. For at-risk communities in particular, these measures represent a chance to alleviate long-standing inequities and ensure that the benefits of emissions reduction investment are distributed first to those who need them most.

Moving forward, success will depend on coupling technical solutions with equity guardrails: ensuring subsidies and incentives reach low-income households, embedding local workforce development in every project, and creating non-digital, accessible pathways for participation. Investments should prioritize community ownership and decision-making, recognizing the value of traditional practices and local knowledge in shaping a just transition.

The path forward is clear: align emissions reductions with community well-being. By grounding emissions reduction strategies in the lived realities of Western Bristol Bay, the region can chart a future that is not only lower in carbon but also more affordable, healthier, and more equitable for all residents.





Dillingham faces a unique combination of challenges and opportunities as it considers pathways for reducing emissions while improving community well-being. The region's emissions profile shows a heavy dependence on residual and distillate fuel oils for heating, a fully diesel-based electricity grid, and freight-dominated transportation. These energy patterns result in disproportionately high costs, significant pollution exposure, and heightened vulnerability to supply disruptions. At the same time, the community's social determinants of health—marked by high energy burdens, elevated poverty rates, and a large renter population—mean that low-income, overburdened residents often experience the most severe impacts.

Mitigation strategies for Dillingham must therefore be designed not only to reduce emissions, but also to address affordability, equity, and resilience. The most promising approaches—clean and affordable heating, renewable and resilient power generation, freight and transportation efficiency, and healthy, resilient homes—offer overlapping benefits that cut across energy, health, and economic well-being. Together, they provide a practical roadmap for a stronger, more equitable, and more sustainable local future.

### Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Clean and Affordable Heating
2. Renewable and Resilient Power Generation
3. Healthy and Resilient Homes and Infrastructure

Together, these three strategies address the largest sources of emissions (heating and power) while also directly improving the economic and health conditions of vulnerable populations. They reduce reliance on expensive imported fuels, cut household energy burdens, and create healthier, more resilient homes. Transportation measures for on-road vehicles remain important but, based on the modeled inventory, deliver comparatively smaller reductions and fewer immediate co-benefits than heating and power strategies. Additional opportunities may emerge over time for marine and aviation services as better data and technologies become available.



## Emissions Data Overview

Total Modeled Emissions: 20,390 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (74.57% of total)

- Residential sector: ~ 46.53% of total emissions
  - Residual Fuel Oil No. 5: ~ 8,100 mt CO<sub>2</sub>e → ~ 39.7% of total emissions
  - Electricity: ~ 1,318 mt CO<sub>2</sub>e → ~ 6.5%
  - Propane: ~ 54 mt CO<sub>2</sub>e → ~ 0.3%
  - Wood and Wood Residuals: ~ 16 mt CO<sub>2</sub>e → ~ 0.1%
- Commercial sector: ~ 28.05% of total emissions
  - Distillate Fuel Oil No. 1: ~ 2,030 mt CO<sub>2</sub>e → ~ 10%
  - Electricity: ~ 3,530 mt CO<sub>2</sub>e → ~ 17.3%
  - Propane: ~ 155 mt CO<sub>2</sub>e → ~ 0.8%
  - Wood and Wood Residuals: ~ 6 mt CO<sub>2</sub>e → ~ 0.03%
- Industrial sector: 0% contribution in this model

### Transportation (25.43%)

- Fuel breakdown:
  - Motor Gasoline: ~ 4,246 mt CO<sub>2</sub>e → ~ 20.8% of total emissions
  - Diesel Fuel: ~ 939 mt CO<sub>2</sub>e → ~ 4.6%
  - Electricity: ~ 0.04 mt CO<sub>2</sub>e (negligible)
- Vehicle types:
  - Trucks (commercial/freight): ~ 4,751 mt CO<sub>2</sub>e → ~ 91.6% of transportation emissions in this model
  - Passenger vehicles: ~ 426 mt CO<sub>2</sub>e → ~ 8.2%
  - Motorcycles: ~ 7 mt CO<sub>2</sub>e → ~ 0.1% Scope note: Transportation emissions in this inventory reflect on-road vehicles only and do not include marine vessels or aircraft, which also play a key role in the local transportation system.

### Electricity Generation

- All modeled electric generation emissions come from diesel:
  - Electricity consumed: ~ 16,831 MWh
  - Diesel generation emissions: ~ 4,847 mt CO<sub>2</sub>e

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Solid waste and wastewater emissions were not included in this dataset.

### Key Takeaways

- Oil dependence dominates: Most emissions come from residual and distillate fuel oils, especially for residential heating and diesel-based electricity generation.
- Stationary sources lead: Roughly three-quarters of emissions are from homes and businesses, reflecting high heating and power demands.
- Transportation impact is freight-heavy: About a quarter of modeled emissions stem from on-road transportation, with trucks and freight vehicles responsible for over 90%. Actual transportation-related emissions are likely higher when unmodeled marine and aviation sources are considered.
- Carbon-intensive electricity: All electricity is produced from diesel, making power use particularly emissions-intensive.



## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Risk:** Anticipated changes in extreme weather are moderate (2.84), indicating that the community faces some vulnerability to increasing weather variability and related natural hazards.
- **Disaster Loss:** Annualized disaster loss is relatively low at \$82,548.54 (6.82 percentile), showing that direct disaster costs are not currently a dominant issue.
- **Air Quality:** Diesel particulate matter exposure is negligible, but air toxics cancer risk is notable at the 10th percentile nationally, indicating modest exposure concerns.
- **Hazardous Facilities:** Proximity to Risk Management Plan (RMP) facilities is significant (77.84 percentile), highlighting potential chemical exposure risks.
- **Housing:** A moderate portion of housing stock predates 1980 (54.55 percentile), which may reflect aging infrastructure vulnerable to environmental stressors.
- **Flood Risk:** About 4% of local properties have flood risk (29 percentile nationally), signaling localized flooding concerns.

Implications: While direct environmental hazards such as toxic releases and hazardous sites are limited, the proximity to RMP facilities and aging housing stock increase community vulnerability to environmental risks. Flood risk may increase due to more extreme weather events and increased coastal erosion. Emissions reduction strategies will need to address health and safety alongside energy transitions.

### Public Health Indicators

- **Chronic Disease Burden:** Asthma (5.4%), diabetes (4.8%), and high blood pressure (15.95%) are all moderate, with percentiles between the mid-50s nationally.
- **Mental Health:** Poor mental health prevalence (7.25%) is moderately high (57 percentile), reflecting community stressors.
- **Life Expectancy:** Average life expectancy is relatively high at 80 years, though national comparisons put low life expectancy at the 34th percentile, suggesting inequities.
- **Cancer Prevalence:** At 2.6% (48.86 percentile), cancer burden is moderate.
- **Heart Disease:** Prevalence is at the 53rd percentile, indicating average levels compared to the nation.

Implications: Overall health outcomes are stable, but chronic conditions and mental health challenges signal a need for integrated health and environmental planning. Emissions-related interventions must avoid worsening existing health disparities.

### Socioeconomic Factors

- **Poverty:** 25.55% live below 200% of the federal poverty line (57 percentile), reflecting economic vulnerability.
- **Education:** Nearly 10% lack a high school diploma, ranking high nationally (79.55 percentile).
- **Employment:** Unemployment is relatively low at 4.7% but still mid-range (55 percentile nationally).
- **Housing:** Renter occupancy is high (47.05%; 76.70 percentile), indicating housing insecurity. Housing cost burden is also significant at 26.54% (53 percentile).
- **Insurance:** A large share (17.4%; 76.42 percentile) of residents are uninsured, reflecting gaps in healthcare access.
- **Digital Access:** 11.9% lack internet access (49 percentile), which may limit education and healthcare access.
- **Demographics:** Youth population is large (31.9%; 89 percentile), and elders (65+) make up nearly 10% (56.82 percentile). Disability prevalence is 12.3% (43 percentile).
- **Energy Costs:** Energy burden is significant (4% of annual cost; 77 percentile), signaling affordability challenges.

Implications: High poverty, renter occupancy, uninsured rates, and energy burden highlight financial fragility. These conditions suggest that emissions reduction strategies must be designed to avoid adding costs and should prioritize equity and affordability.

### Transportation Insecurity

- **Access:** Transportation access is extremely low (0 score, 0 percentile nationally).
- **Cost Burden:** Transportation costs are low (0.13% of household income; 44 percentile nationally), but this may reflect limited options rather than affordable access.
- **Traffic Safety:** No reported fatalities (0 percentile), suggesting low traffic exposure, but likely due to limited infrastructure and access.

**Implications:** Lack of transportation access is a major barrier to healthcare, jobs, and education. Sustainability strategies that require travel or infrastructure adaptation may disproportionately affect residents without adequate transport options.

### Intersection with Emissions Reduction Planning

Dillingham's social determinants reveal a community that is economically constrained, with health and housing vulnerabilities, and very limited transportation access. These conditions imply that:

- **Equity must guide strategy design:** High poverty, uninsured rates, and energy burdens mean sustainability policies should not increase household costs. Instead, they should reduce long-term expenses (e.g., energy efficiency, resilient housing).
- **Health resilience is critical:** Given chronic disease prevalence and mental health concerns, strategies must reduce exposure to pollutants and protect vulnerable populations.
- **Youth and elder demographics matter:** A large youth population and a notable elder community mean that intergenerational health and economic impacts should be explicitly addressed.
- **Infrastructure limitations must be considered:** Transportation and aging housing stock create barriers to adaptation. Strategies should integrate localized, community-based approaches rather than rely solely on large-scale infrastructure.

### Mitigation Strategies

#### Clean and Affordable Heating

Heating is the single largest source of emissions in Dillingham, with households heavily dependent on residual fuel oil. Shifting away from this reliance offers the greatest opportunity for both pollution reduction and cost relief. Transitioning to lower-carbon options such as heat pumps, biomass systems, or shared district heating could substantially reduce the community's carbon footprint while also making home energy bills more affordable. Pairing these upgrades with weatherization and insulation improvements, especially in older homes, would further lower demand and costs. Since nearly half of households are renters and a significant share of residents live below the poverty line, prioritizing affordability and equitable access will be critical.

#### Renewable and Resilient Power Generation

Electricity in Dillingham is generated entirely from diesel, making it one of the most carbon-intensive parts of the energy system. Expanding renewable generation—such as solar, wind, or small-scale hydro—presents a key pathway to both reduce emissions and increase local energy security. Incorporating storage and microgrid systems would enhance reliability in a remote region that is vulnerable to fuel supply chain disruptions. These investments would not only reduce dependence on imported fuels but could also create opportunities for local workforce development, ensuring that the economic benefits of the energy transition stay within the community.

#### Freight and Transportation Efficiency

While passenger vehicles contribute relatively little to overall modeled emissions, freight transport dominates the transportation sector, accounting for more than 90 percent of related emissions in the inventory, largely reflecting Dillingham's dependence on trucking for the movement of goods in and out of the community. At the same time, barges, boats, and aircraft play a critical role in moving cargo

and people, even though their emissions are not captured in the current inventory. Strategies to reduce transportation-related emissions could include electrifying local road fleets where feasible, exploring hybrid systems or low-carbon fuel options for trucks, marine vessels, and aircraft, and improving freight logistics to maximize efficiency. Because transportation access is already limited, these efforts should focus on freight and passenger systems in a way that reduces emissions without creating new barriers to mobility or affordability for residents.

### Healthy and Resilient Homes and Infrastructure

The condition of housing and community infrastructure in Dillingham compounds both health risks and energy burdens. Many homes are older and less efficient, with a moderate share built before 1980, which makes them more expensive to heat and more vulnerable to extreme weather. Upgrading these homes with modern efficiency measures, improved insulation, and healthier building materials would not only reduce emissions but also improve indoor air quality, supporting residents with asthma, heart disease, and other chronic conditions. Integrating resilience measures such as flood-proofing or storm-resistant upgrades would further prepare the community for environmental risks while strengthening long-term public health.

### Improved Outcomes for Overburdened and Underserved Communities

Implementing clean and affordable heating solutions in Dillingham would directly benefit at-risk populations by reducing the high costs of keeping homes warm in a cold climate. Many households already struggle with energy burdens, spending a disproportionate share of their income on fuel. By replacing expensive residual fuel oil with efficient heat pumps, weatherization, or other clean heating systems, families could experience lower utility bills, freeing up resources for other essential needs such as food, healthcare, and education. At the same time, cleaner heating reduces exposure to indoor and outdoor air pollution, supporting better respiratory health outcomes in a community where asthma and other chronic conditions are already concerns.

Transitioning to renewable and resilient power generation would also deliver tangible benefits for vulnerable households. A diesel-dependent grid exposes residents to volatile fuel prices and potential supply disruptions, creating both financial and reliability risks. Locally generated renewable energy would stabilize costs and improve energy security, particularly important for vulnerable residents who may not have backup resources during outages. Over time, this transition would reduce emissions while ensuring that the community is less dependent on external fuel sources. If paired with workforce training, this shift could also expand local job opportunities, offering pathways to economic mobility.

Finally, addressing housing and infrastructure needs ensures that vulnerable populations live in healthier, more resilient homes. Upgrades to insulation, ventilation, and building materials improve indoor air quality and reduce the incidence of health issues linked to poor housing conditions. Enhanced energy efficiency lowers monthly expenses, while flood- and weather-resilient improvements reduce the risk of displacement and loss during extreme events. Together, these changes would reduce both health and financial stressors, leading to improved long-term outcomes for Dillingham's low-income families, elders, youth, and individuals with disabilities.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Clean & Affordable Heating (fuel-switching + weatherization)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                                                                         | Community Benefits                                                                                                                                |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Heating fuels drive the largest slice of emissions (majority of stationary). Feasible long-run reduction: ~20–40% of community-wide GHGs if a large share of homes and public/commercial buildings convert from residual/distillate oil to heat pumps/biomass + deep weatherization. Near-term phased programs could realistically hit ~10–20% over 5–10 yrs. | Strong positive: lowers pollution where people live; prioritizing low-income renters and elders targets highest energy burdens and health risks.  |
| Energy cost savings | High             | Weatherization typically 10–30% heating load reduction; heat pumps can halve delivered-heat cost where electricity rates + performance allow. Household bills could fall 15–40% post-retrofit (range reflects building condition, fuel prices).                                                                                                               | Strong positive: reduces energy burden for low-income households; helps renters if paired with anti-displacement & cost-pass-through protections. |
| Health benefits     | High             | Lower indoor/outdoor combustion byproducts; improved IAQ via air-sealing/ventilation upgrades; benefits for asthma/CVD. Health co-benefits are community-wide, concentrated in substandard/older homes.                                                                                                                                                       | Addresses higher baseline disease burdens and poor housing quality.                                                                               |
| Resilience          | Moderate–High    | Weatherization + efficient heating reduce outage vulnerability (slower heat loss). Where paired with backup power or thermal storage, resilience increases further.                                                                                                                                                                                           | Positive: vulnerable households maintain safer indoor temps during extreme cold/events.                                                           |
| Disbenefits / risks | Moderate         | Upfront cost; contractor capacity constraints; split incentives for renters; possible electric bill increase if heat pumps on diesel-based grid (mitigated with efficiency + power-sector progress); biomass sustainability/air emissions must be managed.                                                                                                    | Risks of rent increases or uneven access—mitigate with income-qualified incentives, landlord covenants, and tenant protections.                   |





### Renewable & Resilient Power Generation (diesel displacement + storage/microgrids)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                 | Community Benefits                                                                                                             |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Power sector $\approx$ ~19% of total emissions. Displacing diesel with renewables + storage could abate ~70–95% of power-sector GHGs over time (~13–18% of community-wide), depending on penetration and curtailment. | Positive: community-scale benefits; cleaner kWh enables low-carbon heating & EVs later, multiplying benefits in at-risk homes. |
| Energy cost savings | Moderate–High    | Levelized costs can undercut imported diesel volatility; community bills can stabilize/decline over time. Savings magnitude depends on financing, capacity factor, O&M, and storage sizing.                           | Positive if savings flow to customers; design tariffs to protect low-income users and reduce arrears/disconnections.           |
| Health benefits     | Moderate         | Reduced local diesel generation lowers NOx/PM near plants; indirect health gains via enabling clean heating/air-quality improvements.                                                                                 | Positive but indirect; benefits grow as heating/electrification follows.                                                       |
| Resilience          | High             | Microgrids + storage reduce outage risk and fuel-supply exposure; critical facilities can island.                                                                                                                     | Strong for clinics, shelters, schools serving vulnerable populations.                                                          |
| Disbenefits / risks | Low–Moderate     | Siting/land use; intermittency if under-sized storage; capital intensity; workforce needs.                                                                                                                            | Ensure equitable siting, local jobs, bill-credit designs that don't bypass low-income households.                              |



### Freight & Transportation Efficiency (targeting heavy vehicles/logistics)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                           | Community Benefits                                                                                                                                   |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Transport $\approx$ ~25% of total; freight $\approx$ >90% of transport emissions. Near-term measures (routing, idle-reduction, efficiency, limited electrification/low-carbon fuels) could yield ~5–10% community-wide reductions over time, higher if viable marine/air cargo measures emerge. | Indirect but meaningful: lower freight costs can reduce prices for essential goods that weigh more on low-income households.                         |
| Energy cost savings | Moderate         | Fleet fuel savings 10–25% via logistics/efficiency; electrification where feasible can reduce TCO, but depends on charging, duty cycles, and power rates.                                                                                                                                       | Potential pass-through to consumer prices if programs encourage competitive freight markets; design incentives to avoid cost transfers to residents. |
| Health benefits     | Moderate         | Less diesel exhaust along freight corridors/loading areas; benefits to workers and adjacent neighborhoods.                                                                                                                                                                                      | Positive for workers and residents near depots/ports; prioritize mitigations where at-risk populations are exposed.                                  |
| Resilience          | Moderate         | More efficient, diversified fuels and local charging/fueling improve supply reliability.                                                                                                                                                                                                        | Helps stabilize availability and affordability of essential goods for vulnerable households.                                                         |
| Disbenefits / risks | Low–Moderate     | Capital costs for fleets, charging/fueling infrastructure; tech fit for cold climates; risk of cost passthrough.                                                                                                                                                                                | Mitigate with grants, phased standards, and consumer-price safeguards.                                                                               |



**Healthy & Resilient Homes & Infrastructure (deep efficiency, IAQ, durability, hazard hardening)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                               | Community Benefits                                                                                             |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Weatherization + envelope upgrades can cut building loads 10–30%; when coupled with clean heating (Category #1), total building-sector reductions compound. As a standalone (without fuel switch), expect ~5–15% community-wide over time (avoid double-counting with Category #1). | Very strong: focuses on older/renter housing, lowers bills and exposure to cold/heat.                          |
| Energy cost savings | High             | Building-level savings 15–30% common; highest payoff in leaky pre-1980 units and public buildings.                                                                                                                                                                                  | Direct relief for low-income renters/homeowners; include no-cost programs and tenant protections.              |
| Health benefits     | High             | Better IAQ (ventilation + filtration), moisture control, mold reduction; fewer exacerbations of asthma/CVD.                                                                                                                                                                         | Strongly positive for at-risk, elders, and children.                                                           |
| Resilience          | High             | Tight, insulated homes maintain safe temps longer; hazard hardening (flood/storm) reduces displacement/loss.                                                                                                                                                                        | Protects those least able to recover from disasters.                                                           |
| Disbenefits / risks | Low–Moderate     | Upfront cost; contractor capacity; split incentives; possible rent hikes post-upgrade.                                                                                                                                                                                              | Require affordability covenants, anti-displacement rules, and local workforce programs to keep benefits local. |





### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy burdens through reduced fuel use and efficiency gains.
- Improved health outcomes via cleaner indoor air, reduced exposure to diesel exhaust, and healthier housing conditions.
- Greater resilience to extreme weather and fuel supply disruptions, protecting vulnerable households.
- Enhanced housing stability through upgrades that make homes safer and more livable.
- Community empowerment and equity if programs prioritize local jobs, renter protections, and access for low-income residents.

Potential disbenefits if not designed equitably:

- Upfront costs may limit access without subsidies or targeted assistance.
- Split incentives between landlords and renters could restrict benefits to tenants.
- Risk of rent increases or displacement if efficiency upgrades are not paired with protections.
- Technology and maintenance challenges in remote, cold-climate conditions.
- Uneven access if programs do not intentionally reach vulnerable households.

### Path Forward

Moving forward, Dillingham can achieve meaningful reductions in emissions while directly improving quality of life for its residents by prioritizing strategies with both high GHG reduction potential and strong benefits. Clean heating and weatherization, renewable power generation, and resilient housing emerge as the most impactful interventions. These approaches cut fuel dependence, lower household costs, and improve health outcomes, all while building local capacity for long-term energy independence.

The path ahead should focus on phased implementation that matches community capacity: early investments in housing efficiency and renewable generation can deliver near-term savings, while longer-term freight, marine, and aviation transportation measures can be layered in as technology, data, and infrastructure evolve. To maximize equity, all strategies must include safeguards for renters, protections against cost burdens, and intentional outreach to low-income households.

By aligning emissions reductions with improvements in social determinants of health, Dillingham has the opportunity to transform emissions reductions into a broader community resilience strategy. This approach will ensure that sustainability action not only reduces pollution but also strengthens health, equity, and economic security for generations to come.



# Fairbanks North Star Borough



Population: 97,327

Census Tracts: 2090000100, 2090000200, 2090000300, 2090000400, 2090000500, 2090000600, 2090000700, 2090000800, 2090001000, 2090001101, 2090001200, 2090001300, 2090001401, 2090001402, 2090001501, 2090001502, 2090001600, 2090001700, 2090001901, 2090001902, 2090980100

Fairbanks North Star Borough faces a dual challenge that is also a clear opportunity: community health is shaped by older housing, winter air-quality episodes, and meaningful energy burdens, while the emissions profile is dominated by stationary combustion in buildings and facilities, with transportation a substantial secondary source. Recent estimates place community emissions near 2.03 million metric tons CO<sub>2</sub>e, with roughly 79% from stationary fuels and 21% from on-road transportation; the heaviest contributors are commercial coal and residential No. 5 fuel oil. These conditions intersect with social determinants of health—higher asthma and cardiovascular risks in older, leaky homes; renter-heavy neighborhoods with limited internet access; and flood- and cold-weather vulnerability that can disrupt essential services. Framing mitigation through this lens ensures that pollution reductions translate directly into healthier, safer, and more affordable living conditions.

This roadmap prioritizes measures that deliver the largest near-term ton reductions while improving outcomes for at-risk households and neighborhoods. The analysis integrates tract-level variation and communitywide indicators to identify where stacked burdens and high-emitting uses overlap—public and commercial facilities heated with coal or oil, older residential stock with high bills and poor indoor air, and corridors where truck activity concentrates exposure. The resulting strategy set emphasizes practical, buildable actions: converting coal- and oil-reliant facilities to cleaner heat with deep efficiency; home weatherization paired with right-sized clean heat; and Railbelt power decarbonization so every electrified load counts more over time. Together, these moves cut emissions at the source, lower energy costs, improve indoor and neighborhood air quality, and strengthen winter resilience—anchoring a just transition whose benefits are most visible where the needs are greatest.



## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Coal-to-clean conversions + deep retro-commissioning in public/commercial hubs
2. Home weatherization with clean-heat options
3. Railbelt power decarbonization (so electrification “counts”)

Fairbanks North Star Borough can cut the most tons fastest by converting coal- and oil-heated public/ commercial facilities, delivering at-risk health and indoor-air gains while lowering operating costs. Pair that with home weatherization and right-sized clean heat to drive down household bills, reduce winter PM exposure, and strengthen cold-weather resilience. As Railbelt electricity decarbonizes, every electrified boiler, heat pump, and fleet mile counts more—amplifying emissions reductions and locking in durable, visible benefits where needs are greatest.

## Emissions Data Overview

Total Modeled Emissions: 2,028,488 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (79.02)

- Residential Sector (21.30%)
  - Residual Fuel Oil No. 5 336,051.82 mt (16.57%)
  - Electricity 65,781.64 mt (3.24%)
  - Natural Gas 25,639.48 mt (1.26%)
  - Propane 3,887.73 mt (0.19%)
  - Wood & Residuals 607.28 mt (0.03%)
- Commercial Sector (25.88%)
  - Bituminous Coal 708,482.86 mt (34.93%)
  - Electricity 223,857.05 mt (11.04%)
  - Distillate Fuel Oil No. 1 88,183.72 mt (4.35%)
  - Natural Gas 49,711.72 mt (2.45%)
  - Propane 6,731.88 mt (0.33%)
  - Wood & Residuals 244.74 mt (0.01%)
- Industrial Sector (24.56%)
  - Distillate Fuel Oil No. 2 82,393.74 mt (4.06%)
  - Distillate Fuel Oil No. 1 10,932.87 mt (0.54%)
  - Kerosene 226.10 mt (0.01%)
  - Natural Gas 142.75 mt (≈0%)
  - Propane 42.24 mt (≈0%)
  - Propane Gas 0.13 mt (≈0%)

### Transportation (20.54%)

By fuel type:

- Motor Gasoline 336,836.88 mt (16.61%)
- Diesel Fuel 88,729.49 mt (4.37%)
- Electricity 4.04 mt (≈0%)

By vehicle type (within transport):

- Trucks: 356,822.03 mt (83.85% of on-road)
- Passenger vehicles: 68,191.31 mt (16.02%)
- Motorcycles: 557.07 mt (0.13%)

### Electricity Generation

- Electricity consumption: 1,111,151.40 MWh
- Generation sources:
  - Coal 477,795.10 MWh → 153,037.77 mt (52.84% of electricity-related CO<sub>2</sub>e)
  - Petroleum 355,568.45 MWh → 102,403.71 mt (35.36%)
  - Natural Gas 166,672.71 MWh → 34,201.24 mt (11.81%)
  - Hydro 66,669.08 MWh → 0 mt
  - Wind 44,446.06 MWh → 0 mt.
  - Nuclear: 741,200.20 MWh → 0

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- Stationary dominates. ~79% of community emissions come from stationary combustion; transportation accounts for ~21%.
- Two big fuel drivers. Commercial coal (~35% of total) and residential No. 5 fuel oil (~17%) are the largest single contributors across all sources.
- Electricity matters—separately. Regional electricity used (~1.11 TWh) is generated largely from coal and petroleum (~88% of electricity CO<sub>2</sub>e); treat these scope-2 emissions separately to avoid double-counting with stationary totals.
- Buildings are the center of gravity. Within stationary sources, commercial uses lead (~53% of total community emissions), followed by residential (~21%) and industrial (~5%).
- On-road is truck-heavy. Transportation emissions are dominated by trucks (~84% of on-road); gasoline and diesel supply nearly all transport CO<sub>2</sub>e.
- Total footprint: about 2.03 million metric tons CO<sub>2</sub>e (community total, 2022).
- Gaps to flag. This view shows 0% for industrial processes, waste/wastewater, and ag/land use, and non-road transportation is not yet incorporated—expect totals and shares to shift as the comprehensive inventory fills these in.
- Equity/affordability link. The reliance on coal, heavy oils, and delivered fuels aligns with known home energy cost and air-quality challenges in older housing and commercial stock—important context for sustainable energy framing (no strategies here, just implications).



## Social Determinants of Health

### Methodology

- **Geographic scope.** The analysis synthesizes multiple census tracts that collectively represent the Fairbanks urban core and adjacent communities (e.g., Downtown, South Fairbanks, Airport Way, College/Aurora, UAF/Farmers Loop, Badger East/West, Greater North Pole, Chena Ridge, Goldstream/Murphy Dome, Salcha, and tracts overlapping military installations).
- **Multi-scale data handling.** When indicators are only available at the census area/borough level, those values are used directly for all included tracts. When tract-level data are available for a subset of tracts, results are summarized with range (min–max), median, and, where useful, interquartile cues to convey spread and heterogeneity across neighborhoods.
- **Distributional emphasis.** Rather than reporting a single average that can mask inequity, the synthesis highlights spatial gradients (e.g., “higher in core tracts, lower in outlying tracts”) and clusters of concern (e.g., older housing near legacy industrial corridors).
- **Outlier treatment.** Tracts exhibiting extreme values (e.g., very high cost burden, disability prevalence, or flood exposure) are flagged qualitatively so their conditions inform interpretation without disproportionately skewing boroughwide signals.
- **Special populations & atypical tracts.** Military-installation tracts and other areas with atypical reporting are incorporated descriptively to preserve context while avoiding distortion of distributional statistics.
- **Interpretive lens.** Indicators are read through a social determinants of health framework—linking environmental exposures, housing conditions, socioeconomic status, transportation access, and demographics—to explain how stacked risks and resources differ across tracts within the same community.

### Environmental & built-environment stressors

- **Flood risk is widespread but uneven.** Many Fairbanks-area tracts show very high shares of properties with flood risk (often ~95–99% in core urban tracts), while several outer tracts are substantially lower (e.g., Steese Hwy ~6%). This indicates an urban flood-exposure gradient intersecting with older neighborhoods and river corridors.
- **Legacy & hazardous facilities proximity clusters in town.** Downtown/Airport/South Fairbanks/Hamilton Acres/Johansen show high national percentiles for proximity to hazardous sites and Superfund areas, reflecting historic industrial/commercial land uses. Outlying residential tracts (e.g., Chena Ridge, Badger East/West, Goldstream/Murphy Dome) generally indicate lower proximity but may experience other risks (e.g., road access, wildfire smoke not explicitly measured here).
- **In Fairbanks, anthropogenic woodsmoke from residential solid-fuel heating—combined with extreme cold, strong temperature inversions, and valley topography that trap emissions near the ground—drives winter pollution episodes, concentrating exposure in neighborhoods with older housing and high heating needs.**
- **Old housing stock is common in core neighborhoods.** Several central tracts register high pre-1980s housing shares (e.g., Downtown ~98th percentile nationally), implying aging structures with probable energy and indoor-air challenges. Outer tracts trend newer, though pockets of older or mobile homes appear in places like FAI/Van Horn and Badger areas.
- **Transportation adjacency.** Central tracts are very close to high-volume roads and the airport, compounding exposure to traffic emissions and noise; outlying tracts have less roadway proximity but longer trip lengths.
- **Anticipated weather extremes vary.** Some outlying tracts (e.g., Chena Ridge, UAF/Farmers Loop, Greater North Pole) show very high anticipated changes in extreme weather compared with certain in-town tracts—important for forward-looking resilience planning.

**Health status (community patterning)**

- Chronic conditions are highly unequal across tracts.
  - In parts of central Fairbanks, asthma ( $\approx 9\text{--}10\%$ ) and poor mental health ( $\approx 13\text{--}14\%$ ) sit in high national percentiles; hypertension and diabetes can be extreme (Downtown: hypertension  $\approx 39\%$ , diabetes  $\approx 11.5\%$ ).
  - Several outlying tracts report much lower chronic disease prevalences and higher life expectancy ( $\approx 79\text{--}83$  years), whereas Downtown shows low life expectancy ( $\approx 65.7$  years), signaling concentrated disadvantage.
- Age & disability structure differ by neighborhood. Downtown has high older-adult and disability shares; bases and some family-oriented areas skew younger with higher child shares. These patterns shape vulnerability to heat/cold, indoor air quality, and emergency response needs.

**Socioeconomic & housing determinants**

- Poverty & housing cost burden concentrate in select tracts. Downtown and some central tracts show very high poverty rates ( $< 200\%$  Federal Poverty Level (FPL)  $\approx 49\%$  in Downtown) and severe cost burden (Downtown  $\approx 62\%$ ). By contrast, several outer or university-adjacent tracts report moderate poverty and lower burden—though exceptions exist.
- Tenure & stability vary. Central tracts have high renter shares (often  $55\text{--}67\%$ ), which can increase displacement risk amid upgrades or shocks; outer tracts are more owner-occupied but can face commuting costs and access barriers.
- Internet access gaps persist. Multiple tracts—both central and some peri-urban—show notable lack of internet access (e.g.,  $23\text{--}35\%$  in some central tracts;  $> 20\%$  in parts of Badger/Chena River Valley), limiting telehealth, education, and access to assistance programs.
- Energy burden is material. Most tracts cluster around  $\approx 2\text{--}4\%$  reported energy burden, with higher burdens in places like Salcha ( $\approx 6\%$ ). Given arctic heating needs, even “moderate” percentages translate into high absolute winter bills, especially for older, inefficient homes.

**Transportation access & safety**

- Access scores hover below national midline in many in-town tracts, reflecting winter constraints and network geometry; outlying tracts sometimes show better access scores but incur higher transportation cost burdens or long travel distances. Traffic fatality rates spike in a few outer tracts (e.g., Goldstream/Murphy Dome, Chena River Valley), underscoring rural road risk.

**Interpretation**

- Concentrated disadvantaged in core Fairbanks. Central tracts combine older housing, high renter share, high cost burden, hazardous-site proximity, and worse health (including very low life expectancy in Downtown). This clustering indicates compounded risk, where environmental exposure, housing quality, and socioeconomic stress mutually reinforce poor outcomes.
- Peripheral communities face distinct risks. Many outlying tracts report lower industrial proximity and better life expectancy, yet contend with extreme-weather exposure, flood pockets, higher transport dependence and costs, and in some places elevated traffic fatality risk—all of which can limit access to care, jobs, and services, especially during disruptions.
- Household energy needs are a cross-cutting vulnerability. Energy burden is meaningful across the Borough, amplified by older stock in city neighborhoods and distance-driven costs in rural/peri-urban areas. Energy insecurity can worsen respiratory and cardiovascular conditions when residents compromise on heating/ventilation.
- Children, elders, and people with disabilities are unevenly distributed. Downtown has high elder and disability rates, several family-oriented tracts have high child shares, and base populations skew very young. Program design and outreach must match these demographic contours.



- Information access is a determinant. Significant internet gaps in multiple tracts limit uptake of incentives, emergency alerts, and tele-services—an equity barrier that can widen health disparities.

### Intersection with Emissions Reduction Planning

#### Equity targeting & sequencing.

- Expect largest health co-benefits when early efforts prioritize central Fairbanks tracts with the heaviest cumulative burdens (old homes, high rent burden, high disease prevalence, low life expectancy). Delivering relief where risk stacks highest supports equitable pollution reductions and visible health gains.

#### Housing & indoor air quality emphasis.

- The combination of older housing and high asthma/poor mental health in core tracts argues for solutions that tighten shells, improve ventilation/filtration, and manage moisture/combustion. Improved indoor air quality reduces exposure to traffic-related and legacy pollutants that infiltrate older structures.

#### Flood-aware implementation.

- With very high property-level flood risk in many in-town tracts, program design should assume flood-compatible upgrades and staging that does not strand vulnerable households. Coordination with mitigation and resilience investments will matter for continuity of benefits.

#### Transportation reality check.

- Below-median access in many tracts and long distances in others mean solutions must acknowledge winter reliability, safety, and trip-dependence. Where traffic fatalities are high, safety co-benefits become material to public support. Outlying areas' higher transport cost burdens suggest that any measure affecting travel costs or fueling logistics could have outsized distributional effects.

#### Energy affordability as a health lever.

- Given meaningful energy burdens (and extreme cold), measures that lower heating bills will likely deliver near-term health and financial relief, especially in tracts with high cost burden and disability/elder shares (e.g., Downtown). Messaging should connect pollution reduction with comfort, respiratory relief, and financial stability.

#### Demographically tailored delivery.

- Tracts with high elders and disabilities will need low-friction enrollment, in-home services, and caregiver coordination; family-heavy tracts may prioritize school-adjacent improvements and child health co-benefits; base-adjacent tracts may require on-installation alignment and distinct outreach channels.

### Bottom line

FNSB shows stacked environmental and socioeconomic stressors in central Fairbanks—older housing, high renter and cost burden, hazardous-site proximity, and worse chronic health and life expectancy—while outer communities tend to have lower industrial proximity but face extreme-weather exposure, flood pockets, longer travel, higher crash risk, and energy affordability challenges. Demographics vary sharply (elders/disabilities concentrated downtown; children and military families elsewhere), and internet gaps cut across multiple places. For emissions reduction, these SDOH patterns point to equity-first prioritization in the most burdened tracts, housing/indoor-air and flood-aware implementation, transport and energy affordability realities, demographically tailored delivery, and offline-capable outreach—so reductions in emissions translate into measurable health and cost relief for those most affected.

## Mitigation Strategies

### Weatherization-first home upgrades with clean-heat options for at-risk households

Lead with whole-home weatherization (air sealing, insulation, ventilation/filtration) and then layer heating upgrades: in-town areas on the Railbelt should add heat pumps where the envelope allows; elsewhere, pair tighter shells with high-efficiency oil or gas equipment and balanced ventilation to cut PM2.5 exposure and asthma triggers. Target the downtown/South Fairbanks tract cluster first (older stock, high renter share, worse respiratory outcomes), and deliver phone/field enrollment for households with limited internet. Use AHFC Weatherization Assistance + forthcoming Home Energy Rebates as the backbone; stand up mobile assessment teams and “bulk buy” campaigns for common measures (attic/roof insulation, minisplits for small apartments, heat-pump water heaters for multifamily). Result: lower bills and better indoor air for at-risk households, plus the largest near-term stationary cuts in neighborhoods with stacked burdens.

### Coal-to-clean conversions and deep retro-commissioning in public/commercial hubs

Concentrate fuel switching and efficiency in the commercial/public sector that dominates local stationary emissions—schools, state/borough buildings, UAF, health campuses, and larger private facilities. Sequence projects by (a) coal or #5/#1 heating oil use, (b) proximity to dense at-risk neighborhoods, and (c) ability to electrify without grid penalties. Measures: plant-level heat recovery, electric or dual-fuel boilers, smart controls, and building recommissioning; add filtration upgrades to reduce indoor exposure during winter inversions. Prioritize facilities that serve schools, clinics, and libraries so health and comfort gains accrue where they matter most, and use phased scopes to fit Alaska procurement and seasonal work windows. This aligns with the plan’s “Non-Residential Weatherization, Energy Efficiency & Beneficial Electrification” track and documented public-asset opportunities.

### Railbelt power decarbonization to make electrification “count” in Fairbanks

Pair building and boiler electrification with cleaner, more reliable Railbelt electricity so scope-2 emissions fall as loads shift. Near- to mid-term, back Dixon Diversion (Bradley Lake expansion) and “community generation & transmission” projects to add dispatchable hydro and enable more variable renewables; this cushions the looming Cook Inlet gas shortfall, stabilizes rates for at-risk customers, and raises the emissions value of every new heat pump, electric boiler, and EV mile in the Borough. Messaging: “cleaner electrons first” accelerates health and affordability benefits for households that electrify space/water heat.

### Truck-heavy transportation tune-up with risk-oriented charging and fleet swaps

Because trucks dominate on-road emissions, target high-mileage public and private fleets for idle-reduction tech, winter-grade maintenance (tires, alignment, telematics), route consolidation, and staged turnover to cleaner drivetrains. Site fast-charge depots where duty cycles justify them (municipal yards, delivery hubs, school bus barns) and place public chargers where at-risk residents actually park—near affordable housing, libraries, clinics—using Alaska’s NEVI-aligned siting logic. In the PM2.5 nonattainment area, prioritizing bus and refuse-truck upgrades delivers outsized air-quality co-benefits for at-risk neighborhoods along freight corridors and arterials.

### Methane and organics: quick wins that also lower community costs

Capture methane at regional landfills and expand organics diversion/composting to trim powerful GHGs while cutting waste handling costs that hit fixed-income households. For Fairbanks-area planning, adopt the Central Peninsula model for landfill gas utilization (flare or beneficial use) and pair it with phased food-waste diversion modeled on Southeast’s tribal/municipal composting programs. Tie training and jobs to focused hiring, and use schools and community gardens as offtakers for compost to reinforce local food and soil goals. These projects deliver measurable CO<sub>2</sub>e cuts quickly and create budget headroom that can be reinvested in community services.

### Improved Outcomes for Overburdened and Underserved Communities

Investing first where at-risk households live, work, and learn delivers immediate health and cost-of-living gains. Tightening older homes and upgrading heat and ventilation reduce winter PM<sub>2.5</sub> infiltration and indoor combustion byproducts linked to asthma and cardiovascular stress, while lowering monthly energy bills that strain fixed incomes. Prioritizing public buildings and schools that serve at-risk residents improves thermal comfort and indoor air quality in the places people spend their days, and cuts operating costs that can be redirected to community services. Aligning landfill methane capture and organics diversion with local hiring creates accessible jobs and training pathways, while reducing nuisance odors and truck traffic near neighborhoods that often border waste infrastructure.

On the mobility side, replacing the heaviest emitters on at-risk routes—transit, school buses, and refuse trucks—reduces roadside exposure to diesel exhaust and winter inversion pollution. Locating reliable charging where at-risk residents actually park (multifamily lots, libraries, clinics) expands access to cheaper-per-mile transportation, not just for early adopters. As Railbelt electricity cleans up, every electrified mile and every electric heat hour in at-risk areas yields larger pollution and bill savings, building household resilience against extreme cold snaps, fuel price swings, and flood-related disruptions. Together, these efforts translate mitigation into lived improvements—healthier air, warmer and safer homes, lower utility and transport costs, and fair access to the benefits of the clean-energy transition.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

#### Weatherization-first home upgrades + clean-heat options

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                        | Community Benefits                                                                                                                       |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Treating 20–50% of homes with 20–50% average savings yields ~20–110 ktCO <sub>2</sub> e/yr (residential ≈432 ktCO <sub>2</sub> e/yr). Biggest gains where No.5 oil is displaced and envelopes are tightened. | Targets neighborhoods with older stock and higher fuel oil dependence; direct household emissions cuts accrue where burdens are highest. |
| Energy cost savings | High             | Typical cold-climate weatherization + right-sized clean heat can trim 15–30%+ space/water heat use; in oil-heated homes this often means hundreds to low-thousands of dollars/yr per household.              | Reduces energy burden for at-risk households; phone/field enrollment overcomes low-internet access.                                      |
| Health benefits     | High             | Better ventilation/filtration and reduced indoor combustion lower PM <sub>2.5</sub> /NO <sub>x</sub> exposure; improvements most pronounced in older, leaky homes.                                           | Asthma/CVD risk reduction and thermal comfort gains for at-risk residents in central tracts.                                             |
| Resilience          | High             | Tighter shells, balanced ventilation, and flood-aware measures improve survivability in extreme cold and during power/fuel disruptions.                                                                      | Stabilizes indoor temps and air quality for vulnerable residents; lowers outage sensitivity.                                             |
| Disbenefits / risks | Moderate         | Upfront costs; split incentives for renters; sub-optimal performance if heat pumps are undersized or without envelope fixes; winter COP variability.                                                         | Mitigate via incentives, landlord participation rules, and mobile installation teams.                                                    |

## Coal-to-clean conversions &amp; deep retro-commissioning in public/commercial hubs

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                       | Community Benefits                                                                                                                |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Commercial coal $\approx 708$ ktCO <sub>2</sub> e/yr ( $\approx 35\%$ of community total). Converting 10–40% of that load or replacing with high-efficiency/ electric boilers can yield 70–300 ktCO <sub>2</sub> e/yr reductions; retro-commissioning adds 5–15% savings across facilities. | Prioritize facilities serving schools, clinics, and libraries; local air-quality and comfort benefits accrue to users/ community. |
| Energy cost savings | Moderate–High    | Retro-commissioning often pays back quickly; fuel-switch economics vary with delivered fuel vs. electric rates and grid mix. Portfolio-level O&M savings are material.                                                                                                                      | Lower operating costs can free public budgets for essential services.                                                             |
| Health benefits     | Moderate–High    | Less on-site coal/ oil combustion and better filtration improve indoor air in high-occupancy buildings; localized PM reductions around stacks.                                                                                                                                              | Benefits concentrated where at-risk residents learn/work/seek services.                                                           |
| Resilience          | Moderate         | Controls upgrades and heat-recovery improve reliability; electric conversion depends on grid availability/redundancy.                                                                                                                                                                       | Reliability improvements at critical facilities (shelters, clinics) aid outcomes in disruptions.                                  |
| Disbenefits / risks | Moderate         | High capex; construction disruptions; potential grid capacity constraints; fuel price volatility if relying on delivered fuels.                                                                                                                                                             | Sequence projects to avoid service interruptions in community facilities.                                                         |





**Railbelt power decarbonization (so electrification “counts”)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                               | Community Benefits                                                                                  |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Electricity-related CO <sub>2</sub> e ≈ 290 kt/yr (coal + petroleum + gas). A 20–40% reduction via cleaner generation/transmission yields ~60–120 ktCO <sub>2</sub> e/yr; larger as projects scale. | Increases the emissions benefit of at-risk home electrification and public/commercial boiler swaps. |
| Energy cost savings | Moderate         | Portfolio of dispatchable hydro + optimized transmission can stabilize/limit rate spikes vs. delivered fuels; effects accumulate system-wide.                                                       | Rate stability helps at-risk households/facilities manage bills as they electrify.                  |
| Health benefits     | Moderate         | Reduced stack emissions at generation; additional co-benefits realized indirectly as buildings/vehicles electrify.                                                                                  | At-risk areas gain most when paired with on-the-ground electrification.                             |
| Resilience          | High             | More dispatchable/renewable capacity and stronger transmission increase winter reliability and reduce fuel-supply risk.                                                                             | Low-income neighborhoods benefit from fewer/shorter outages impacting heat and health.              |
| Disbenefits / risks | Low–Moderate     | Upfront capital and potential near-term rate impacts; sequencing risk with electrification pace.                                                                                                    | Provide targeted bill-support/uptake programs during transition.                                    |

**Truck-heavy transportation tune-up (fleet efficiency + targeted electrification/charging)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                    | Community Benefits                                                                                   |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | On-road ≈ 426 ktCO <sub>2</sub> e/yr; trucks dominate. Idle-reduction/ops measures can save 5–10% in targeted fleets; early turnover/electrification of buses/refuse/delivery can yield ~5–40 ktCO <sub>2</sub> e/yr depending on scale. | Prioritize routes through at-risk corridors and vehicles that frequently operate near homes/schools. |
| Energy cost savings | Moderate         | Telematics, tires, routing cut fuel use; depot charging can reduce \$/mile for suitable duty cycles.                                                                                                                                     | Lower operating costs can shield service rates (transit/refuse) for at-risk communities.             |
| Health benefits     | Moderate–High    | Cutting diesel exhaust near residences and schools reduces exposure to NO <sub>x</sub> /PM during winter inversions.                                                                                                                     | At-risk neighborhoods near arterials see disproportionate air-quality gains.                         |
| Resilience          | Moderate         | Better maintenance and routing improve winter reliability; electrified fleets need cold-weather charging redundancy.                                                                                                                     | Service continuity (transit/refuse) is critical for at-risk households.                              |
| Disbenefits / risks | Moderate         | Cold-weather range/performance constraints; charger downtime; capex and workforce needs.                                                                                                                                                 | Mitigate by siting chargers where at-risk residents park and ensuring depot reliability.             |

**Methane & organics (landfill gas capture + diversion/compost)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                             | Community Benefits                                                                       |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Even though current snapshot shows 0% for waste, typical regional landfill gas capture/diversion can deliver order-of-magnitude ~10–50 ktCO <sub>2</sub> e/yr depending on waste volumes and capture/utilization. | Reduces odors and local nuisances often borne by at-risk neighborhoods near waste sites. |
| Energy cost savings | Low–Moderate     | Beneficial use of collected gas offsets purchased energy; organics diversion can reduce hauling/landfill costs over time.                                                                                         | Savings can be reinvested in community services and rate relief.                         |
| Health benefits     | Moderate         | Fewer landfill emissions/odors; less heavy-truck traffic for waste hauling with local diversion.                                                                                                                  | Quality-of-life and nuisance reductions for nearby at-risk communities.                  |
| Resilience          | Moderate         | Local organics management and energy recovery diversify local resources and reduce dependency on long hauls.                                                                                                      | Creates local jobs/training accessible to at-risk workers.                               |
| Disbenefits / risks | Low–Moderate     | Project sizing/financing risk; contamination in organics streams; O&M needs.                                                                                                                                      | Pair with community education and at-risk hiring/training.                               |

**Cross-Cutting Community Benefits and Disbenefits**

Across all strategies, benefits for community benefits include:

- Lower monthly energy bills from weatherization, efficiency, and right-sized electrification.
- Healthier indoor air (less PM/NO<sub>x</sub>), better thermal comfort in older homes and public buildings.
- Cleaner air along bus/refuse/freight routes serving at-risk neighborhoods.
- More reliable heat and essential services during cold snaps and outages.
- Easier access when enrollment is phone/field-based and services are delivered in-home or via trusted local hubs.
- Job pathways and contractor demand tied to local hiring, with training accessible to at-risk workers.
- Budget relief for schools/clinics/libraries that can be reinvested in community services.
- Reduced nuisance burdens near landfills/transfer stations (odors, truck traffic), plus community compost benefits.

Potential disbenefits if not designed equitably:

- Upfront costs and rate impacts during project build-out if protections aren't in place.
- Split incentives for renters; risk of rent hikes or displacement after upgrades.
- Construction disruptions at facilities that at-risk residents rely on (schools, clinics).
- Grid or charger reliability gaps that could strand early adopters or fleets in cold weather.
- Underperformance of heat pumps or EVs if designs ignore Fairbanks operating conditions.
- Digital divide limiting awareness and uptake if programs rely on online-only enrollment.
- Program complexity and paperwork burdens that deter participation.
- Waste/organics contamination or O&M issues that erode promised local benefits.

## Path Forward

Fairbanks North Star Borough's path to durable, equitable decarbonization is clear: focus first on the biggest sources and the places where benefits matter most. Converting coal- and oil-reliant public and commercial facilities, delivering home weatherization with clean heat, and accelerating Railbelt power decarbonization together address the bulk of current emissions while improving indoor air, lowering bills, and strengthening cold-weather resilience. These actions are practical, sequenced, and mutually reinforcing—cleaner power makes electrification count more; tighter buildings make clean heat perform better; public-sector upgrades model success and free operating dollars for community services.

By pairing ton reductions with measurable health and affordability gains, the Borough can build durable support, demonstrate early wins, and create a foundation for subsequent phases in transportation, waste, and community resilience. The result is a roadmap that not only hits emission reduction milestones but also delivers visible improvements for at-risk households—warmer, healthier homes; cleaner neighborhood air; and more reliable essential services—ensuring the benefits of the transition reach those who need them most.





# Haines Borough

Population: 2,537

Census Tract: 2100000100

Communities: Covenant Life, Excursion Inlet, Haines, Lutak, Mosquito Lake, Mud Bay

Haines: By LCGS Russ, wikimedia

Haines Borough, Alaska, faces a unique intersection of environmental, social, and economic conditions that shape its pathway toward air pollution reduction. The community's emissions profile is dominated by fuel oil used for residential and commercial heating and by gasoline and diesel consumption in truck-based transportation. Electricity emissions are comparatively minor, with hydropower already playing an important role in local supply. At the same time, the borough's social determinants of health reveal both strengths and vulnerabilities: residents enjoy a relatively high life expectancy, yet a large share of households live with elevated energy burdens, limited transportation access, and high rates of disability and poverty.

These realities underscore the importance of developing mitigation strategies that not only reduce criteria pollutants and greenhouse gas emissions but also advance equity, affordability, and resilience. For communities of concern, the benefits of cleaner energy, improved housing, and more accessible transportation are inseparable from the broader goals of health equity and economic security. By integrating emissions reduction with community well-being, Haines Borough can position itself as a model for small, rural communities pursuing emissions reduction action while safeguarding vulnerable populations.

This analysis presents four categories of mitigation strategies—transitioning heating systems, advancing clean transportation, strengthening energy infrastructure, and building community resilience—with explicit attention to their benefits, risks, and implications for beneficial outcomes. Together, these strategies form the foundation for a roadmap that will align local priorities with the State's Sustainable Energy Action Plan.



## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Transition from Fuel Oil Heating to Clean Energy
2. Affordable, Low-Emission Transportation Access
3. Resilient Clean Energy Infrastructure (Hydro + Storage + Microgrids)

Together, these strategies form a high-benefit package—delivering deep emissions cuts while addressing energy burden, health, and resilience challenges for the community's most vulnerable households.

## Emissions Data Overview

Total Modeled Emissions: 10,320 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (63.4%)

- Residential Sector (59.78%)
  - Electricity: 13.48 mt CO<sub>2</sub>e (0.13 %)
  - Natural Gas: 219.54 mt CO<sub>2</sub>e (2.13 %)
  - Residual Fuel Oil No. 5: 5,794.45 mt CO<sub>2</sub>e (56.15 %)
  - Wood and wood residuals: 142.2 mt CO<sub>2</sub>e (1.38 %)
- Commercial Sector (5.94%)
  - Distillate Fuel Oil No. 1: 346.12 mt CO<sub>2</sub>e (3.35 %)
  - Propane: 26.42 mt CO<sub>2</sub>e (0.26 %)
  - Wood and wood residuals (commercial): 0.96 mt CO<sub>2</sub>e (0.01 %)
- Industrial Sector: 0%. No direct emissions from industrial combustion processes were reported.

### Transportation (36.60%)

Fuel breakdown

- Motor Gasoline: 2,865.12 mt CO<sub>2</sub>e (27.76 % of total emissions)
- Diesel Fuel: 911.92 mt CO<sub>2</sub>e (8.84 %)
- Electricity (for vehicles / electric traction): 0.28 mt CO<sub>2</sub>e (0.00 %, essentially negligible)

Vehicle type shares

- Truck: 3,461.85 mt CO<sub>2</sub>e / 91.65 % of transportation emissions
- Passenger (cars, light vehicles): 308.24 mt CO<sub>2</sub>e / 8.16 %
- Motorcycle: 7.23 mt CO<sub>2</sub>e / 0.19 %

### Electricity Generation

- Total electricity used: 85.33 MWh
- Generation sources:
  - Hydro: 37.55 MWh → 0.00 mt CO<sub>2</sub>e
  - Petroleum (on-site generation using petroleum fuels): 47.79 MWh → 13.76 mt CO<sub>2</sub>e

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- Dominant emissions driver: Stationary combustion (heating, facility fuel use), especially via Residual Fuel Oil No.5, is the largest single contributor.
- Transportation is a major secondary source, especially through truck use and heavy reliance on gasoline/diesel.
- Electricity generation emissions are minimal, due in part to hydro supply and limited local fossil-fuel generation.
- Clean electricity is already in place to some degree (hydro), which means reducing reliance on oil in heating/combustion and transport are central levers.

## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather:** Anticipated changes are moderately high (43.75 percentile), meaning the community faces notable risks from shifting extreme weather patterns.
- **Disaster Loss:** Annualized disaster loss is \$604,879, placing the region in the 33rd percentile nationally, indicating moderate but tangible risk.
- **Air Quality & Toxics:** Diesel PM exposure is very low (0.01), but cancer risk from air toxics is 8.00. Toxic releases rank at the 47th percentile nationally.
- **Hazardous Sites:** The area has some proximity to hazardous waste (12th percentile) and risk management facilities (70th percentile), suggesting potential localized exposures.
- **Flood Risk:** 10% of properties face flood risk (64th percentile nationally), reflecting vulnerability to environment-driven flooding.
- **Other Factors:** The community contains a formerly used defense site, which may present legacy contamination issues.

Implications: Haines Borough faces a mixed environmental landscape—relatively low exposure to air pollutants but moderate vulnerability to flooding, hazardous sites, and disaster-related losses. These environmental stressors may compound health and infrastructure risks over time, especially as severe weather events and natural hazards become more frequent or intense.

### Public Health Indicators

- **Chronic Illness:** Asthma (3.13%), diabetes (3.17%), and high blood pressure (11.67%) prevalence are moderate compared to national patterns. Heart disease ranks high (60th percentile).
- **Cancer:** Prevalence is 2.40%, placing the community near the 43rd percentile nationally.
- **Mental Health:** Poor mental health prevalence (3.9%) is relatively low, but stigma and access to care may be barriers in small communities.
- **Life Expectancy:** At 82.6 years, residents live longer than the national average, with low rankings for “low life expectancy.”

Implications: Overall health outcomes are favorable, especially life expectancy, but elevated risks from heart disease highlight vulnerability. Chronic disease management and resilience against environmental stressors are critical for long-term well-being.

### Socioeconomic Factors

- **Poverty:** 25.36% live below 200% of the federal poverty line (56th percentile nationally).
- **Education:** Only 2% lack a high school diploma, which is low nationally.
- **Employment:** Unemployment is 5.3%, ranking in the 64th percentile—higher than many U.S. areas.
- **Housing & Costs:** Nearly 40% of housing units are renter-occupied (66th percentile), and 22% of households face cost burdens. Median home value is \$254,000.
- **Insurance & Internet:** Uninsured rate (9.5%) and limited internet access (13.4%) suggest gaps in healthcare and digital infrastructure.
- **Demographics:** Nearly 23% of the population is over 65, while 34% are under 17. Disability prevalence is high at 19% (91st percentile).
- **Energy Burden:** Average household energy burden is 3% (72nd percentile), reflecting high energy costs relative to income.

Implications: Haines Borough shows economic vulnerability with relatively high poverty, unemployment, and energy burden. The large proportion of elderly, youth, and residents with disabilities signals elevated dependence on resilient infrastructure and accessible services.

### Transportation Insecurity

- Access: Transportation access score is very low (0.66), ranking in the 88th percentile for insecurity.
- Cost: Transportation costs are 15% of household spending (68th percentile).
- Safety: Traffic fatalities are 3.16 per 100,000 (69th percentile nationally).

**Implications:** Transportation insecurity is a significant barrier, with limited access and high costs reducing mobility. Safety concerns compound this challenge, leaving vulnerable populations particularly at risk during emergencies and extreme weather events.

### Intersection with Emissions Reduction Planning

The social determinants of health in Haines Borough create both constraints and priorities for emissions reduction planning:

- High vulnerability populations (elderly, youth, disabled) require strategies that ensure equitable access to clean energy, transportation alternatives, and health protections.
- Transportation insecurity highlights the importance of reliable, affordable, and low-emission transit solutions.
- Energy burden and housing cost pressures suggest that efficiency improvements and renewable energy adoption could reduce household strain while advancing emissions reduction goals.
- Environmental hazards like flood risk and legacy contamination emphasize the need to align pollution reduction with resilience planning.
- Moderate-to-high disaster exposure means emissions reduction efforts should be integrated with preparedness for extreme weather.

Overall, emissions reduction strategies for Haines Borough must be designed with attention to equity, affordability, and resilience, ensuring that vulnerable groups benefit from and are not disproportionately burdened by future policies.

### Mitigation Strategies

#### Transition from Fuel Oil Heating to Clean Energy

Haines Borough's largest emissions source is stationary combustion, primarily from residual fuel oil No. 5 used in residential and commercial heating. This dependence not only drives criteria pollutants and greenhouse gas emissions but also exacerbates energy burden for households, especially since nearly a quarter of the population lives near or below the poverty line and energy costs already rank in the 72nd percentile nationally. Transitioning to cleaner heating sources would reduce both emissions and household vulnerability. Strategies could include incentivizing heat pump adoption, expanding access to weatherization and efficiency upgrades in older housing stock (noting the high proportion of pre-1980 and pre-1960 homes), and exploring district heating solutions powered by renewable electricity or biomass. Pairing these upgrades with subsidies or on-bill financing can help ensure low-income and elderly households—who represent a significant share of the population—are not left behind.

#### Clean and Affordable Transportation Options

Transportation emissions, particularly from trucks and heavy reliance on gasoline and diesel, make up more than a third of the community's carbon footprint. At the same time, transportation insecurity is high, with limited access and elevated cost burdens. This means that mitigation strategies must balance emissions reduction with improvements in mobility. Investment in low-emission community transit—such as demand-responsive shuttles or vanpool programs—could reduce both household dependence on private vehicles and the high transportation costs many face. For freight and trucking, pilot programs that introduce renewable diesel, biodiesel, or electrification for short-haul fleets could be explored. Expanding EV charging infrastructure, coupled with incentives for light vehicle electrification, would lay the groundwork for a gradual shift in personal vehicle use. Importantly, strategies should prioritize accessibility for older adults and people with disabilities, who are disproportionately affected by limited mobility options.

### Resilient Energy Infrastructure and Grid Decarbonization

While emissions from electricity are currently small, the region benefits from an existing hydro resource, giving Haines Borough a strong foundation for clean power. Expanding and modernizing this renewable capacity would not only support electrification of heating and transportation but also improve resilience against environmental disruptions. Strategies include strengthening local hydro infrastructure, exploring battery storage or microgrid development for backup power in extreme weather, and ensuring that power distribution reaches remote or underserved households. Because many residents are already burdened by energy costs, programs should focus on ensuring that expanded renewable infrastructure reduces long-term household expenses. By aligning resilience with decarbonization, the borough can protect its most vulnerable populations during disasters while positioning the grid to support widespread electrification.

### Whole-Home Weatherization and Healthy Housing Upgrades

Mitigation strategies should explicitly link emissions reduction with improvements in community health and resilience. High rates of heart disease and disability, combined with exposure to flood risk and legacy defense sites, suggest the need for holistic interventions. Expanding home weatherization and air quality improvements reduces both fuel demand and health risks from indoor and outdoor pollutants. Developing green infrastructure for flood mitigation—such as restoring wetlands or reinforcing natural barriers—can simultaneously reduce disaster loss and improve air and water quality. Education and outreach campaigns focused on healthy housing, energy efficiency, and disaster preparedness could empower residents, while workforce training in clean energy and resilience sectors would provide local economic opportunity. In this way, mitigation becomes a tool not just for emissions reduction but for advancing long-term health equity and socioeconomic stability.

### Improved Outcomes for Overburdened and Underserved Communities

Implementing these mitigation strategies will deliver substantial benefits for at-risk populations in Haines Borough, who currently face elevated energy burdens, transportation insecurity, and health disparities. By reducing reliance on costly residual fuel oil through efficiency upgrades and electrification, households will experience lower utility costs and healthier indoor environments. Expanding accessible, low-emission transportation options will ease mobility challenges for older adults, youth, and individuals with disabilities while reducing exposure to traffic-related air pollution. Investments in resilient, renewable energy infrastructure will strengthen community preparedness against extreme weather and disaster losses, ensuring that vulnerable populations are not disproportionately affected during crises. Together, these actions create pathways to cleaner air, more affordable living, and greater health equity, ensuring that at-risk households benefit first and most from emissions reduction efforts.



Haines: By Diego Delso, Wikimedia



**Benefit (Disbenefit) Quantification or Qualitative Analysis**

**Transition from Fuel Oil Heating to Clean Energy (heat pumps, deep weatherization, targeted fuel-switching, small district systems, limited sustainable biomass)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                        | Community Benefits                                                                                                                                                           |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Residual Fuel Oil No. 5 drives ~5,800 mt CO <sub>2</sub> e (~56% of total). Replacing 50% of oil heat with heat pumps + weatherization could avoid ~2,700–3,200 mt; 70–90% penetration could reach 4,000–5,200 mt over time. | High — lowers pollution and energy burden for low-income renters, elders, and households with disabilities when upgrades and incentives are targeted first to at-risk homes. |
| Energy cost savings | High             | Typical combined savings from envelope upgrades + heat pumps 15–40% on space heat; higher in leaky pre-1980/1960 homes. Bill relief is durable in cold seasons.                                                              | High — reduces energy burden (already high percentile). On-bill financing/grants can eliminate upfront barriers.                                                             |
| Health benefits     | Moderate–High    | Lower indoor combustion, less oil soot/odors, better indoor temps and humidity; potential PM reductions where oil appliances are replaced.                                                                                   | High — improves comfort and respiratory outcomes in standard housing; beneficial for elders and people with chronic disease.                                                 |
| Resilience          | High             | Weatherization reduces outage impacts; heat pumps + backup (thermal storage, limited gen) stabilize winter comfort; district loops/microgrids can island critical facilities.                                                | High — protects medically vulnerable residents; prioritizable to at-risk housing and shelters.                                                                               |
| Disbenefits / risks | Low–Moderate     | Upfront costs; cold-climate performance requires proper sizing/envelopes; grid capacity in some areas; biomass use risks local air quality if not best-available tech.                                                       | Manageable with equity guardrails — direct-install programs, free audits, no-cost remediation; avoid biomass in dense areas without strict emissions controls.               |



**Clean and Affordable Transportation Options (demand-responsive transit/vanpools, EV readiness, light-duty EV adoption, renewable diesel/biodiesel pilots for trucks and equipment)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                     | Community Benefits                                                                                                                         |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Transport $\approx$ 3,800 mt CO <sub>2</sub> e total; trucks $\approx$ 3,450 mt. Near-term 10–20% fuel switch/electrification in fleets yields $\sim$ 400–700 mt; longer-term 50% conversion could reach $\sim$ 1,800 mt. | High — better shared mobility cuts cost barriers; cleaner air near roads benefits children and elders.                                     |
| Energy cost savings | Moderate         | EV light-duty per-mile costs typically 30–60% lower; fleet fuel mgmt savings for renewable diesel can be modest-to-moderate; transit/vanpools reduce household vehicle miles.                                             | Subsidized passes, dial-a-ride, and employer vanpools reduce transportation cost burden (already elevated).                                |
| Health benefits     | Moderate         | Reduced tailpipe NO <sub>x</sub> /PM exposure; fewer traffic emissions hotspots if mode shift succeeds.                                                                                                                   | High — benefits sensitive groups (youth, elders, people with heart/lung disease).                                                          |
| Resilience          | Moderate         | Community shuttles improve access during storms; diversified fuels + local charging add redundancy.                                                                                                                       | High — ensures mobility for those without vehicles or with disabilities during emergencies.                                                |
| Disbenefits / risks | Moderate         | High vehicle capex; charger reliability in cold; renewable diesel supply/price variability; limited grid capacity at depots.                                                                                              | Mitigate via design — prioritize public/affordable charging in at-risk areas, fare assistance, route design around essential destinations. |



**Resilient Energy Infrastructure & Grid Decarbonization (hydro upgrades, storage, microgrids at critical facilities, targeted distribution upgrades)**

| Outcome             | Potential Impact               | Quantitative / Qualitative Assessment                                                                                                                  | Community Benefits                                                                                                        |
|---------------------|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low (direct) / High (enabling) | Electricity emissions are ~14 mt today; upgrades don't cut much directly but enable deep electrification of heat and transport (see Categories 1 & 2). | High — reliable, cleaner power allows at-risk households to adopt heat pumps/EVs without fear of outages or bill spikes.  |
| Energy cost savings | Moderate                       | Storage/microgrids can avoid diesel peaking and outage costs; long-run O&M savings; potential tariff stabilization.                                    | Stable tariffs and outage reduction help fixed-income households most.                                                    |
| Health benefits     | Low–Moderate                   | Fewer outage-related health harms (cold exposure, spoiled meds), reduced reliance on backup diesel gensets.                                            | High (targeted) — prioritize clinics, senior housing, shelters, and remote clusters serving at-risk residents.            |
| Resilience          | High                           | Islandable microgrids for critical services; storage smooths hydro variability; hardened lines reduce storm impacts.                                   | High — ensures continuity of heat/meds/communications for vulnerable residents.                                           |
| Disbenefits / risks | Moderate                       | Capital intensity; permitting/siting; potential hydrologic/ecosystem constraints.                                                                      | Address via process — equity screens in siting, community benefits agreements, bill protections during recovery of costs. |

**Whole-Home Weatherization and Healthy Housing Upgrades (whole-home weatherization + IAQ fixes, healthy housing remediation, green infrastructure for flood, workforce training)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                             | Community Benefits                                                                                       |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Efficiency across oil-heated homes can trim ~5–10% of community fossil heat load (roughly ~300–600 mt if scaled). | High — delivers savings without requiring fuel switch first; ideal for renters and manufactured housing. |
| Energy cost savings | High             | Air sealing/insulation/windows + HVAC tune-ups yield persistent bill cuts, especially in older stock.             | High — immediate comfort and bill relief for low-income and fixed-income households.                     |
| Health benefits     | High             | Better IAQ (mold, moisture, combustion safety), warmer homes, fewer exacerbations for heart/lung disease.         | High — directly targets households with elevated health risks and disability prevalence.                 |
| Resilience          | High             | Green infrastructure lowers flood exposure; hardened homes reduce disaster losses and displacement.               | High — focuses on high-risk blocks and rental properties to prevent disproportionate impacts.            |
| Disbenefits / risks | Low–Moderate     | Retrofit disruptions; landlord pass-throughs could raise rents; maintenance needs for GI.                         | Mitigate with policy — tenant protections, no-cost retrofits, O&M plans embedded in grants               |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy costs through weatherization, heat pumps, and clean heating transitions.
- Improved health outcomes from reduced indoor fuel oil combustion and cleaner transportation air quality.
- Greater mobility and access via affordable, low-emission transit and vanpools, helping seniors, youth, and people with disabilities.
- Enhanced resilience from microgrids, renewable electricity, and hardened housing, ensuring continuity of critical services during outages and storms.
- Equity in implementation when programs prioritize low-income renters, older housing stock, and vulnerable households first.
- Local economic opportunities from clean energy and resilience workforce training targeted at community members.

Potential disbenefits if not designed equitably:

- Upfront costs or rent pass-throughs if upgrades raise housing costs without protections.
- Disruption during retrofits (temporary relocation, construction impacts) may be harder on vulnerable households.
- Technology adoption barriers such as limited internet access, digital literacy, or financing constraints.
- Grid or infrastructure strain if electrification expands faster than upgrades.
- Unequal benefits if wealthier households adopt clean technologies first, leaving at-risk households behind.
- Fuel supply or reliability risks if alternative fuels (biomass, renewable diesel) are not well regulated for quality and emissions.

### Path Forward

Haines Borough stands at a critical juncture where emissions reduction can be directly aligned with improved health, affordability, and resilience for its residents. The emissions profile is clear: heating with residual fuel oil and transportation reliant on gasoline and diesel dominate local criteria pollutants and greenhouse gas emissions, while electricity is already relatively clean due to hydropower. At the same time, social determinants of health highlight both the challenges and opportunities: high energy burdens, transportation insecurity, older housing stock, and a large share of low-income, elderly, and disabled residents who are disproportionately vulnerable to environmental and economic stressors.

The most impactful strategies—transitioning heating systems, expanding affordable low-emission transportation, strengthening clean energy infrastructure, and advancing weatherization and healthy housing—offer a pathway that reduces emissions while centering equity. These actions not only cut pollution but also deliver immediate and lasting benefits: lower household costs, improved indoor air quality, greater access to mobility, and stronger protection from disasters. By prioritizing at-risk households, Haines can ensure that those most at risk are also the first to benefit.

Moving forward, the path should focus on phased implementation with equity-first design. In the near term, investment in weatherization, clean heating pilots, and affordable mobility programs can deliver fast wins. In parallel, planning for resilient energy infrastructure and expanded EV readiness will enable longer-term transitions. Partnerships with state and federal programs, tribal entities, utilities, and community organizations will be essential to mobilize resources and align efforts with Alaska's broader Sustainable Energy Action Plan.

Ultimately, the path forward for Haines Borough is not just about reducing emissions—it is about building a healthier, more resilient, and more equitable community. By embedding equity into every stage of the transition, the borough can ensure sustainability actions strengthen the well-being of all residents, especially those who need it most.



# Hoonah-Angoon Census Area

Population: 2,248

Census Tract: 2105000400

Communities: Klukwan, Angoon, Elfin Cove, Game Creek, Gustavus, Hoonah, Pelican, Tenakee Springs, Whitestone Logging Camp



The Hoonah–Angoon Census Area faces a complex set of environmental, economic, and health-related challenges that shape both its long-term resilience and opportunities for improvement. The region’s energy profile is heavily dependent on petroleum-based fuels used for heating, transportation, and electricity generation, resulting in high energy costs and exposure to fuel price volatility. At the same time, households experience higher-than-average energy burdens, limited transportation access, and constraints in healthcare and digital connectivity. An aging population and a significant share of residents living with disabilities or fixed incomes further highlight the need for programs that strengthen household stability and regional self-sufficiency.

Addressing these interconnected challenges requires an approach that links energy efficiency, infrastructure modernization, and community health. By improving building performance, expanding access to reliable and affordable energy, and strengthening local systems, the region can lower household expenses, enhance quality of life, and support a more sustainable local economy. The strategies outlined in this analysis emphasize coordinated action across heating, transportation, and power systems, alongside investments in equity, workforce development, and environmental stewardship. Together, they form a foundation for a healthier, more resilient, and more energy-secure Hoonah–Angoon.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Transition from Petroleum Heating to Clean, Efficient Systems
2. Electrification of Local Transportation (with Shared Mobility Models)
3. Expansion of Renewable Microgrids and Community-Owned Clean Power

Together, these strategies target the region’s largest emissions sources, while delivering direct affordability, health, and equity benefits for vulnerable residents.

## Emissions Data Overview

Total Modeled Emissions: 16,847 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (59.99%)

- Residential Sector (39.75%)
  - Electricity: 968.91 mt CO<sub>2</sub>e (5.75 %)
  - Natural Gas: 150.21 mt CO<sub>2</sub>e (0.89 %)
  - Propane: 95.26 mt CO<sub>2</sub>e (0.57 %)
  - Residual Fuel Oil No. 5: 5,385.28 mt CO<sub>2</sub>e (31.97 %)
  - Wood and wood residuals: 96.94 mt CO<sub>2</sub>e (0.58 %)
- Commercial Sector (20.24%)
  - Distillate Fuel Oil No. 1: 2069.32 mt CO<sub>2</sub>e (12.28 %)
  - Propane : 157.97 mt CO<sub>2</sub>e (0.94 %)
  - Electricity: 1,176.26 mt CO<sub>2</sub>e (6.98 %)
  - Wood and wood residuals: 5.74 mt CO<sub>2</sub>e (0.03 %)
- Industrial Sector: 0%. No direct emissions from industrial combustion processes were reported.

### Transportation (40.01%)

#### By fuel type

- Diesel fuel: 1,453.04 mt CO<sub>2</sub>e (8.62 %)
- Motor gasoline: 5,287.42 mt CO<sub>2</sub>e (31.39 %)
- Electricity: 0.52 mt CO<sub>2</sub>e (~0 %)

#### By vehicle type

- Trucks: 6,267.74 mt CO<sub>2</sub>e (92.98 %)
- Passenger vehicles: 463.21 mt CO<sub>2</sub>e (6.87 %)
- Motorcycles: 10.3 mt CO<sub>2</sub>e (0.15 %)

### Electricity Generation

- Electricity consumption: 11,288.39 MWh
- Generation sources:
  - Petroleum: 7,450.34 MWh → 2,145.70 mt CO<sub>2</sub>e (100 % of generation emissions)
  - Hydro: 7,450.34 MWh → 0 mt CO<sub>2</sub>e

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- Petroleum reliance drives emissions: Heating fuels (residual and distillate oils) and petroleum-based electricity generation together make up the majority of emissions.
- Transportation is a major contributor: Nearly 40% of emissions come from vehicles, with trucks accounting for over 90% of transportation-related CO<sub>2</sub>e.
- Residential heating is the single largest source: Fuel oil used in homes contributes ~32% of total emissions, underscoring household energy dependence.
- Electricity is partly low-carbon: Hydroelectric power supplies about one-third of local electricity, but petroleum fuels dominate the rest, creating notable emissions.

## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Risk:** Anticipated changes in extreme weather are moderately high (35.23), indicating the community is exposed to environment-related disruptions.
- **Disaster Losses:** The annualized disaster loss percentile is 65.34, translating to over \$1.26 million in projected damages—a significant financial vulnerability.
- **Air Quality & Toxics:** Diesel PM exposure is low (0.01), but cancer risk from air toxics scores at 8.0, indicating moderate exposure relative to national levels.
- **Hazardous Facilities:** Risk Management Plan (RMP) facilities are present, scoring high nationally (67.61 percentile), despite no hazardous waste or Superfund proximity.
- **Legacy Contamination:** Presence of formerly used defense sites suggests potential contamination or land-use restrictions.
- **Housing Age & Infrastructure:** Pre-1980s housing is relatively high (42.27%), with implications for energy efficiency and health risks from older building stock.
- **Transportation Exposure:** Proximity to high-volume roads and airports is low, minimizing localized air quality risks.

Implications: Environmental risks are less about current pollution burdens and more about legacy hazards, environment-related disasters, and aging infrastructure, all of which increase vulnerability and create barriers to resilience.

### Public Health Indicators

- **Chronic Diseases:** Rates of asthma (3.41%), cancer (2.11%), and high blood pressure (12.12%) are moderate, though diabetes prevalence (4.38%) is above average (51.7 percentile nationally).
- **Mental Health:** Poor mental health prevalence is low (4.51%), but community resources may still be limited given rural isolation.
- **Heart Disease:** Strikingly high—80th percentile nationally, pointing to systemic cardiovascular risks.
- **Life Expectancy:** At 79.3 years, it is slightly above national averages, though lower life expectancy risk ranks at the 42nd percentile.

Implications: The region faces notable health burdens in heart disease and diabetes, which intersect with environmental and socioeconomic stressors. Public health vulnerabilities may reduce adaptive capacity for environmental changes.

### Socioeconomic Factors

- **Poverty:** Nearly one-third of residents live below 200% of the poverty line (30.59%), placing the area in the 74th percentile nationally.
- **Education:** 6% of adults lack a high school diploma, just below national midpoint.
- **Employment:** Unemployment is high (6.8%), ranking in the 80th percentile.
- **Housing:** Renter-occupied units are 26.75%, while cost burden is relatively low (16.03%), suggesting limited but stable housing affordability. Median home value is \$226,700, slightly above national averages.
- **Insurance & Healthcare Access:** Nearly 23% are uninsured (91st percentile nationally)—a major barrier to health resilience.
- **Digital Divide:** Lack of internet access is extremely high (39.1%, 97th percentile nationally), limiting access to telehealth, education, and remote work.
- **Energy Burden:** Households spend ~5% of income on energy costs, ranking in the 91st percentile—significantly constraining household budgets.
- **Inequality:** GINI index at 0.44 (82nd percentile) indicates high income inequality.



- Demographics: Older adults (65+) make up 22.62% of the population, while children (under 17) make up only 12.97%. Disabilities are common (17.6%, 87th percentile).

Implications: The community is economically vulnerable, with high poverty, unemployment, energy burden, and digital exclusion. Combined with limited healthcare access, these factors compound risks from environmental challenges.

### Transportation Insecurity

- Access & Cost: Transportation access score is low (0.43, 75th percentile) and cost burden is significant (76th percentile), suggesting mobility challenges in a geographically isolated region.
- Traffic Safety: Fatalities are moderately high (71.59 percentile), reflecting risk in limited road networks.

Implications: Transportation insecurity contributes to social and economic isolation, restricting access to jobs, healthcare, emergency services, and other essential community resources.

### Intersection with Emissions Reduction Planning

The social determinants of health in Hoonah-Angoon reveal a community highly vulnerable to both economic stress and environmental change. Several intersecting factors will shape their perspective on emissions reduction strategies:

- Energy Burden & Inequality: High household energy costs and inequality mean residents will likely prioritize affordability and fairness in energy transition policies.
- Digital & Transportation Barriers: Lack of internet and high transportation costs restrict access to information, participation in planning, and adoption of new technologies.
- Health Burdens: High prevalence of heart disease and diabetes may limit adaptive capacity and underscore the need for strategies that also deliver co-benefits to public health.
- Aging & Disability: Older adults and people with disabilities will require inclusive planning that ensures resilience investments do not leave them behind.
- Environmental Legacy Issues: Contamination and aging housing stock make remediation and modernization efforts urgent, creating opportunities to integrate pollution reduction with infrastructure upgrades.

Overall, these conditions mean that Hoonah-Angoon's approach to emissions reduction will need to center on equity, affordability, and community resilience, ensuring that strategies address both environmental risks and the deep social determinants of health shaping local vulnerability.





## Mitigation Strategies

### Clean and Affordable Heating Solutions

Residential heating with fuel oils is the single largest source of emissions in the region, and it also places a significant financial burden on households already struggling with high energy costs and poverty rates. A transition to cleaner, more efficient heating systems could dramatically reduce emissions while improving affordability and health outcomes. Strategies might include replacing oil furnaces with air-source or ground-source heat pumps, expanding access to weatherization programs, and incentivizing biomass or renewable-based heating where culturally and ecologically appropriate. Pairing these upgrades with subsidies and community-based financing will ensure that low-income and older residents—who make up a large share of the population—are not left behind.

### Low-Carbon Transportation and Mobility

Transportation is the second-largest source of emissions, particularly from trucks and other petroleum-fueled vehicles. The region's isolation, high fuel costs, and transportation insecurity amplify the impacts of these emissions. Effective strategies could include supporting community-scale electric vehicle (EV) adoption, particularly for light-duty vehicles, while also piloting electric or hybrid public service and freight vehicles where feasible. Investments in charging infrastructure powered by renewable energy would build resilience, while promoting shared transportation services could reduce household costs and expand access for those without reliable mobility. Emphasis should be placed on solutions that are logistically feasible in rural Alaska, such as electrifying fleets used by schools, health services, and local governments.

### Renewable and Resilient Electricity Generation

Although hydroelectric power already provides a portion of the region's electricity, petroleum still dominates generation and accounts for over 2,000 mt CO<sub>2</sub>e annually. Expanding and modernizing renewable capacity—particularly small-scale hydro, solar, or wind microgrids—would further displace petroleum reliance. Community-based microgrid systems could also improve reliability, especially during extreme weather events. Coupling this with battery storage investments would support energy security while lowering emissions. For households, integrating community solar or shared renewable projects would help overcome high upfront costs and address the digital and income inequalities that limit individual access.

### Building Equity and Community Resilience

Mitigation efforts must explicitly address the community's socioeconomic vulnerabilities, including high energy burdens, lack of internet access, and significant rates of disability and aging. Embedding equity-first policies into emissions reduction strategies ensures benefits are widely shared. This might include energy assistance programs tied to clean technology upgrades, training and workforce programs for local residents to participate in clean energy jobs, and health co-benefits planning that reduces exposure to pollutants while improving cardiovascular and respiratory outcomes. Because internet access is limited, outreach must also be designed for accessibility—ensuring that information about programs reaches all residents, not just those online.

### Integrated Land and Environmental Stewardship

While emissions from agriculture, waste, and industrial sources are unknown, stewardship strategies can still support carbon reduction and align with Indigenous values of land and resource care. Examples include forest management for carbon sequestration, incorporating traditional ecological knowledge into resilience planning, and exploring community composting or waste-to-energy pilots that improve waste management while creating local benefits. Although not major emission categories today, these efforts can strengthen long-term resilience and ensure that mitigation aligns with cultural and ecological priorities.

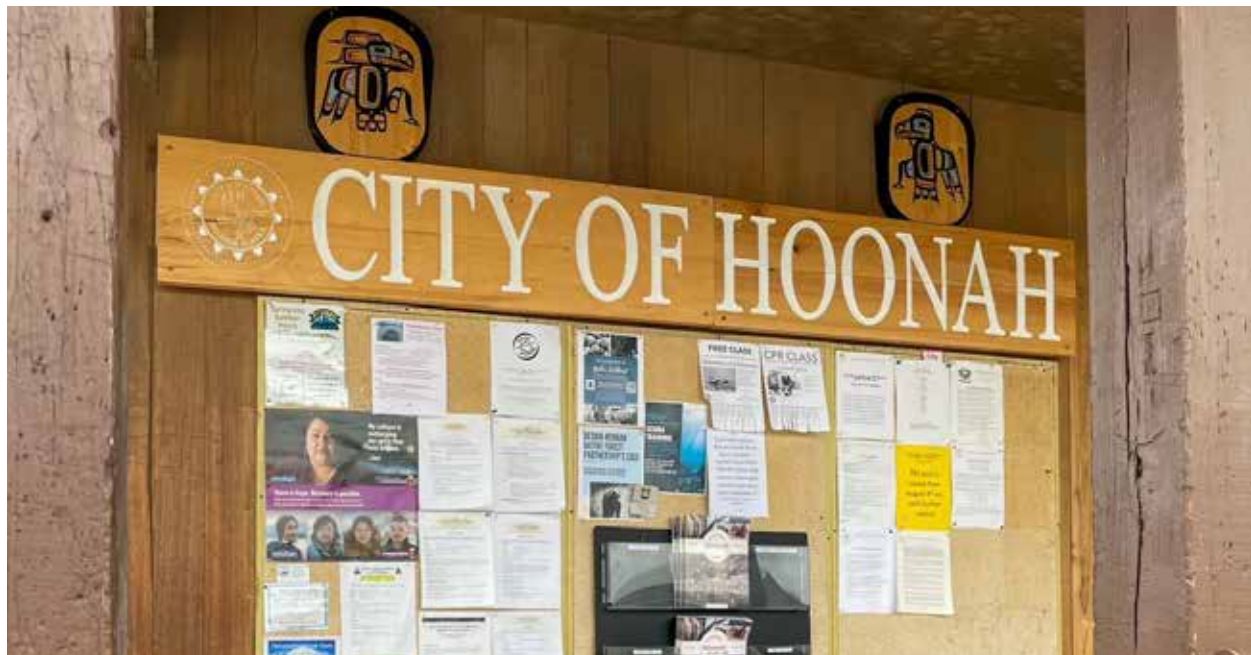
### Improved Outcomes for Overburdened and Underserved Communities

Improved mitigation strategies in Hoonah–Angoon can deliver substantial co-benefits for at-risk communities, particularly where high energy burdens and health disparities overlap. Transitioning from petroleum-based heating fuels to efficient, renewable systems directly reduces household energy costs, which are disproportionately high in this region. For low-income households—many of whom spend more than average on basic utilities—these changes free up limited income for food, healthcare, and other essentials. At the same time, weatherization and clean heating upgrades reduce exposure to indoor air pollutants, improving respiratory and cardiovascular health outcomes for vulnerable residents, including elders and those living with chronic conditions such as heart disease and diabetes.

Transportation improvements also hold significant equity potential. Currently, high fuel costs and limited access create isolation, especially for households without reliable vehicles or with mobility challenges. Introducing cleaner, more affordable transportation options—such as community EV fleets, shared mobility services, and improved freight efficiency—enhances access to schools, healthcare, and economic opportunities. For vulnerable communities, this not only reduces emissions but also strengthens social inclusion, helping residents connect more readily to jobs, services, and cultural activities.

Electricity sector investments can further shift outcomes for at-risk communities. Expanding renewable microgrids and shared solar opportunities ensures that clean energy benefits reach renters and households unable to afford individual systems. By embedding subsidies, community ownership models, and job training into these projects, the region can empower residents to directly participate in and benefit from the energy transition. Importantly, reducing reliance on imported fuels improves community resilience to price shocks and supply chain disruptions—challenges that hit low-income residents the hardest.

Finally, centering equity in emissions reduction fosters long-term improvements in health and well-being. Addressing the digital divide, for example, ensures that program information, incentives, and resources reach residents who currently lack internet access. Pairing mitigation efforts with workforce training opens pathways to employment in the clean energy sector, helping reduce unemployment and inequality. These outcomes mean that sustainability action is not only about reducing emissions but also about building healthier, more resilient, and more equitable communities, where those most impacted by economic and health vulnerabilities see the greatest improvements in quality of life.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Clean Heating Transition (fuel oil → heat pumps/efficiency; targeted weatherization)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                  | Community Benefits                                                                                                                                          |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Residential residual No.5 oil ≈ 5,385 mt CO <sub>2</sub> e/yr; commercial distillate ≈ 2,069 mt CO <sub>2</sub> e/yr. Converting 25–50% of oil-heated load via weatherization + heat pumps could cut roughly 1,900–3,700 mt CO <sub>2</sub> e/yr (≈ 11–22% of total regional emissions).               | Strong: Directly reduces emissions where low-income households are over-represented in inefficient, oil-heated homes.                                       |
| Energy cost savings | High             | Typical oil→heat pump savings \$1,200–\$2,400 per home per year (often ~500 gal avoided), with additional 15–30% from weatherization. Community scale: every 100 homes converted ≈ \$120k–\$240k/yr aggregate savings (before PCE interactions).                                                       | Very strong: Reduces energy burden (notably high locally). Earmarking rebates + no-cost weatherization for low-income/elders maximizes equity.              |
| Health benefits     | High             | Less indoor combustion and fewer fuel storage/handling exposures; improved indoor air quality (mold/moisture mitigation via weatherization). Expected reductions in respiratory & cardiovascular stressors (heart disease/diabetes are elevated regionally).                                           | Homes with elders, children, and people with disabilities benefit most from improved IAQ and thermal comfort.                                               |
| Resilience          | High             | Cuts reliance on bulk fuel deliveries; fewer outage-sensitive oil systems; better building envelopes retain heat during disruptions. Aligns with hydro-supplied electricity where available.                                                                                                           | Strong: Lower vulnerability to price shocks and supply chain delays that disproportionately affect low-income residents.                                    |
| Disbenefits / risks | Moderate         | Upfront cost, contractor scarcity, cold-climate heat pump sizing/defrost performance, panel upgrades, and grid capacity in partial-hydro towns. Mitigations: weatherization-first, bulk procurements, contractor training, load management, targeted incentives for low-income households and renters. | If incentives are not income-tested or renter-friendly, benefits can bypass at-risk residents. Program design must cover full cost for very-low-income home |

### Transportation Electrification (community fleets, shared mobility, charging)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                          | Community Benefits                                                                                                                                          |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | On-road gasoline $\approx 5,287$ mt CO <sub>2</sub> e/yr; diesel $\approx 1,453$ mt CO <sub>2</sub> e/yr. Electrifying 10–25% of VMT could reduce $\sim 670$ –1,700 mt CO <sub>2</sub> e/yr (assuming hydro-dominant charging where available). Priority: trucks & high-mileage public service/fleet vehicles. | High: Cleaner air near roads; prioritizing school/clinic/tribal/local gov fleets delivers broad community benefit first.                                    |
| Energy cost savings | Moderate–High    | Fuel + O&M savings significant for fleets (EVs typically 30–60% lower fuel cost equivalent; maintenance savings common). For households, relief depends on charger access and electricity tariff.                                                                                                              | Medium–High: Shared EVs, e-shuttles, and fare support reduce mobility costs for residents without reliable vehicles.                                        |
| Health benefits     | Moderate–High    | Tailpipe NOx/PM drops where vehicles operate; benefits concentrate along freight/arterials and near schools/clinics.                                                                                                                                                                                           | High for at-risk communities if routes serve vulnerable neighborhoods first and anti-idling + route planning reduce localized exposure.                     |
| Resilience          | Moderate         | Less exposure to petroleum price spikes; vehicle-to-load (V2L) or limited V2B can support critical loads in outages; depends on reliable local generation.                                                                                                                                                     | Medium–High: Reliable community transport to healthcare and services during disruptions especially benefits low-income elders and people with disabilities. |
| Disbenefits / risks | Moderate         | Rural range constraints, charger uptime, winter performance, capital cost, and grid upgrades. Mitigations: depot fast-charging for fleets, cold-weather EV specs, smart siting with hydro-adjacency, operations funding, and community chargers in multifamily/renter areas.                                   | If charging is sited only in affluent or tourist zones, access gaps widen; ensure siting in at-risk tracts and offer discounted rates/transport credits.    |





**Renewable Microgrids & Community-Owned Clean Power (hydro/solar/wind + storage)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                  | Community Benefits                                                                                                                          |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Petroleum-based generation $\approx 2,146$ mt CO <sub>2</sub> e/yr. Replacing 50–75% of diesel-fired MWh with renewables/storage yields $\sim 1,070$ – $1,610$ mt CO <sub>2</sub> e/yr reduction. Additional gains if heating/transport electrify into a cleaner grid. | High: Cleaner grid multiplies benefits from heat pumps/EVs; community ownership shares value with low-income ratepayers.                    |
| Energy cost savings | Moderate–High    | Levelized costs vary, but displacing diesel narrows long-run rate volatility; storage improves dispatch and diesel runtime. Community solar can deliver fixed-bill or %-bill credits to low-income subscribers.                                                        | High: Design tariffs to guarantee bill relief for income-qualified customers; protect PCE eligibility while sharing savings.                |
| Health benefits     | Moderate         | Reduced generator runtime lowers local criteria pollutants and noise; indirect health gains via cheaper, cleaner electricity enabling electrified heating/cooking.                                                                                                     | Medium–High: Community facilities (schools/clinics) prioritize clean, reliable power; renters access benefits via shared solar.             |
| Resilience          | High             | Storage-enabled microgrids improve islanded operation, black-start, and critical-load support; fewer fuel deliveries required.                                                                                                                                         | High: Critical services (water, wastewater, clinics) stay online during disruptions—key for vulnerable residents.                           |
| Disbenefits / risks | Moderate         | Capital intensity, O&M skills, intermittency, and interconnection upgrades; risk of rate impacts if financing is regressive. Mitigations: grants + concessional finance, local O&M training, storage right-sizing, and risk-first tariff design.                       | If cost recovery raises base rates without protections, low-income households could be harmed; pair with bill credits and arrearage relief. |



**Building Equity & Community Resilience (program design, access, workforce, protections)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                              | Community Benefits                                                                                                                                   |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Equity-first delivery (income-qualified rebates, turnkey installs, renter protections) typically boosts adoption of clean heating/EE/EV by 10–30% versus generic programs; that uplift applied to local heating/transport baselines can add ~300–900 mt CO <sub>2</sub> e/yr beyond core measures. | Direct: Ensures reductions accrue where burdens and barriers are highest; lifts participation in tracts with high energy burden, disability, elders. |
| Energy cost savings | High             | If 200–300 low-income households receive deep weatherization + heat pumps, aggregate savings ≈ \$300k–\$700k/yr; add bill credits/arrearage relief for immediate impact. Workforce pathways reduce household precarity via stable wages.                                                           | Very strong: Lowers energy burden for households least able to absorb price shocks; renter safeguards prevent split-incentive lockout.               |
| Health benefits     | High             | Targeted IAQ fixes (ventilation, moisture control) + combustion removal reduce respiratory/cardiovascular stressors; improved mobility access (transit/EV rides) reduces missed care.                                                                                                              | Very strong: Prioritizes elders, people with disabilities, and medically vulnerable residents; reduces exposure to pollutants and cold stress.       |
| Resilience          | High             | Trusted messengers, non-digital enrollment, and local installers shorten time-to-service; resilience add-ons (backup heat, critical-load wiring) keep vulnerable residents safe during outages/extreme weather.                                                                                    | High: Tailors outage support, wellness checks, and critical-load support to at-risk households and community facilities.                             |
| Disbenefits / risks | Moderate         | Program complexity, admin cost, contractor scarcity, and risk of inequitable landlord behavior. Mitigations: simple applications, concierge delivery, local hiring/training, anti-displacement policies, renter protections, performance-based incentives.                                         | If unmanaged, benefits can bypass vulnerable communities due to paperwork, credit checks, or landlord refusal; design must remove these barriers.    |

**Integrated Land & Environmental Stewardship (organics/composting, waste minimization, forest/blue-carbon stewardship)**

| Outcome             | Potential Impact                                                              | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                          | Community Benefits                                                                                                                                          |
|---------------------|-------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate (direct, near-term) / Potentially High (long-term sequestration) | Local organics diversion (e.g., 100–300 tons/yr) can avoid ~50–150 mt CO <sub>2</sub> e/yr (methane averted + hauling reductions). Forest/blue-carbon stewardship may add material sequestration but requires inventories, baselines, and MRV to quantify.                                                     | Medium: Benefits accrue if siting/jobs and soil amendments reach villages/households with limited services; cultural stewardship strengthens participation. |
| Energy cost savings | Low–Moderate                                                                  | Avoided waste shipping/tipping, reduced diesel use for hauling, and local compost value; savings scale with tonnage and logistics (order: tens of thousands \$/yr at small scale).                                                                                                                             | Medium: Savings can stabilize municipal fees; local soil inputs reduce costs for community gardens and subsistence-supporting projects.                     |
| Health benefits     | Moderate                                                                      | Less open dumping/burning reduces particulates; better waste handling protects water sources; compost improves local food initiatives (nutrition, mental well-being from community gardens).                                                                                                                   | High when facilities, training, and garden programs are placed in/near vulnerable areas and schools/clinics.                                                |
| Resilience          | Moderate–High                                                                 | Reduced dependence on long-haul waste export; soil building and local food systems cushion supply disruptions; fuel savings from fewer haul trips; forest/shoreline stewardship reduces hazard and erosion risks.                                                                                              | High: Enhances food and environmental security for remote households; community-led stewardship aligns with cultural practices.                             |
| Disbenefits / risks | Moderate                                                                      | O&M burden, contamination in organics streams, nuisance vectors/odors if mismanaged; permitting and MRV complexity for sequestration; small systems can struggle without steady funding. Mitigations: phased pilots, operator training, source-separation education, right-sized tech, multi-year O&M funding. | If under-resourced, facilities can fail in at-risk areas; ensure equitable siting, reliable O&M, and no fee spikes for low-income users.                    |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy burden → Direct cost savings from cleaner heating, cheaper transportation, and shared renewable power reduce strain on low-income households.
- Improved health outcomes → Reduced exposure to indoor/outdoor pollutants (oil heating, vehicle exhaust, diesel generation) benefits residents with high rates of heart disease, asthma, and diabetes.
- Greater resilience → Renewable microgrids, efficiency, and weatherized homes protect vulnerable populations during extreme weather and supply disruptions.
- Equitable access → Community-owned projects, shared EV fleets, and income-qualified programs ensure renters, elders, and people with disabilities gain direct benefits.
- Local opportunity → Workforce training and stewardship projects create jobs, building capacity and economic inclusion for vulnerable groups.

Potential disbenefits if not designed equitably:

- High upfront costs → Without subsidies or protections, clean tech transitions may bypass low-income households and worsen inequities.
- Access barriers → Limited internet, paperwork, or landlord participation could exclude renters, elders, and digitally disconnected residents.
- Infrastructure strain → Grid limitations, charging gaps, or insufficient O&M funding could leave at-risk communities with less reliable service.
- Unintended cost shifts → If project financing raises rates or fees without safeguards, the most vulnerable households could see higher bills.
- Capacity challenges → Limited local contractors or workforce gaps may delay benefits or raise costs, especially in remote areas.

### Path Forward

The findings highlight clear opportunities for improving both energy and community outcomes in Hoonah–Angoon. Transitioning away from petroleum dependency in heating, transportation, and electricity offers immediate and long-term benefits—reducing fuel costs, improving indoor and outdoor air quality, and strengthening local infrastructure reliability. These efforts also support broader goals of community well-being, creating opportunities for skill development, local employment, and improved access to essential services.

The path forward will depend on a phased and coordinated implementation strategy.

- Short-term actions can focus on efficiency measures that deliver rapid cost savings and household comfort, such as weatherization and energy-efficient heating upgrades.
- Medium-term priorities include expanding renewable and distributed energy systems, modernizing transportation networks, and building workforce capacity to sustain ongoing improvements.
- Long-term investments should strengthen local governance, resource management, and stewardship to ensure that future generations benefit from reliable infrastructure, economic stability, and a healthy environment.

By connecting energy efficiency, affordability, and public health within a single framework, the region can move toward a more stable and self-reliant future—one that improves daily life for residents while fostering economic and environmental resilience across Hoonah–Angoon.





This roadmap starts with a clear view of current conditions in the Kenai Peninsula Borough—linking social determinants of health (SDOH) with the State of Alaska 2022 community greenhouse-gas (GHG) profile, developed as part of the Comprehensive Sustainable Energy Action Plan—to guide practical, high-impact action. Communities across the peninsula differ markedly in size, access, and risk: some sit near industrial corridors and highways; others are remote with older housing and limited connectivity. These differences shape exposure to environmental stressors, the affordability of energy, and the ability to participate in programs. To advance equity, the analysis emphasizes places where energy burdens, health vulnerabilities, and access constraints are greatest.

The emissions profile shows a borough dominated by stationary energy use (heating and process heat in homes, commercial buildings, and industry), with transportation—especially trucks—forming the second major wedge. Long winters and aging housing stock drive heating loads; industrial facilities concentrate process heat; and essential goods movement relies on trucks along key corridors. Actions that reduce fuel use and improve indoor air quality can therefore deliver meaningful emissions reductions alongside tangible improvements in comfort, affordability, and resilience.

### Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Weatherization + clean heat for homes and small buildings
2. Targeted upgrades to large industrial heat loads
3. Truck-focused transportation efficiency and cleaner fuels

These strategies align the borough's biggest emissions sources (building heat, industrial process heat, and truck transport) with measures that are technically mature, scalable, and cost-effective. Together they can produce large near-term tonnage while improving affordability, indoor/outdoor air quality, and resilience—especially for at-risk households—creating momentum for longer-lead transformations (like broader electrification and supply decarbonization).

## Emissions Data Overview

Total Modeled Emissions: 914,417 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (27.46%)

- Residential Sector (41.64%)
  - Residual Fuel Oil No. 5: 75,591.86 mt CO<sub>2</sub>e (8.27% of community).
  - Natural gas: 131,351.80 mt CO<sub>2</sub>e (14.36%).
  - Electricity: 39,621.26 mt CO<sub>2</sub>e (4.33%)
  - Propane: 3,816.29 mt CO<sub>2</sub>e (0.42%).
  - Wood & wood residuals: 690.67 mt CO<sub>2</sub>e (0.08%).
- Commercial Sector (19.26%)
  - Distillate Fuel Oil No. 1: 55,312.13 mt CO<sub>2</sub>e (6.05%).
  - Natural Gas: 50,473.58 mt CO<sub>2</sub>e (5.52%).
  - Propane: 4,222.49 mt CO<sub>2</sub>e (0.46%).
  - Electricity : 65,915.55 mt CO<sub>2</sub>e (7.21%).
  - Wood & wood residuals: 153.51 mt CO<sub>2</sub>e (0.02%).
- Industrial Sector (24.36%)
  - Distillate Fuel Oil No. 2: 0.27 mt CO<sub>2</sub>e (Negligible).
  - Natural Gas: 222,668.84 mt CO<sub>2</sub>e (24.36%).
  - Used oil: 227.63 mt CO<sub>2</sub>e (0.09%).

### Transportation (28.93%)

By fuel type:

- Motor gasoline: 191,017.24 mt CO<sub>2</sub>e (20.89% of community).
- Diesel fuel: 73,531.12 mt CO<sub>2</sub>e (8.04%).
- Electricity: 3.05 mt CO<sub>2</sub>e (Negligible)

By vehicle type (within transport):

- Trucks: 235,059.66 mt CO<sub>2</sub>e (88.85% of transport emissions)
- Passenger vehicles: 28,845.61 mt CO<sub>2</sub>e (10.9%)
- Motorcycles: 646.15 mt CO<sub>2</sub>e (0.24%)

### Electricity Generation

- Electricity consumption: 461,170.78 MWh
- Generation sources:
  - Hydro: 9,223.42 → 0 mt CO<sub>2</sub>e
  - Petroleum: 166,021.48 → 47,814.19 mt CO<sub>2</sub>e (45.30%)
  - Natural Gas: 281,314.18 → 57,725.67 mt CO<sub>2</sub>e (54.70%)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- Buildings drive the footprint. About 70%+ of community emissions come from stationary combustion (homes, commercial, industrial), making space/water heating and process heat the dominant levers.
- Transport is the second pillar. Roughly 30% is on-road transportation, and within that, trucks account for the vast majority of on-road emissions; gasoline is the single largest on-road fuel contributor, with diesel a strong second.
- Natural gas is the anchor fuel. Across sectors, natural gas is the largest single fuel source of emissions (especially in industrial and residential heating), with meaningful contributions from distillate/residual oils in specific sub-sectors and locations.

- Electricity's upstream footprint is mostly fossil. Community electricity use is supplied largely by natural gas and petroleum generation, with minimal hydro in the current mix—so electrification only reduces emissions if paired with cleaner supply or efficiency that cuts kWh.
- Residential load matters. The residential sector alone represents a sizable share of total emissions (heating-dominant), signaling high potential for building shell upgrades and heating fuel shifts (not evaluating which).
- Industrial heat is concentrated. Industrial natural gas use is a major single slice; addressing a handful of large loads could shift totals more than many small dispersed actions (again, not prescribing what).
- Oil heat remains nontrivial. Distillate/residual oils still appear across residential and commercial heating, creating pockets where fuel-switch and efficiency could have outsized impact on local air quality and emissions (strategy evaluation later).
- EV signal is nascent. On-road electricity emissions are near zero, implying very low EV penetration today; any future uptake would shift emissions toward the power mix.

## Social Determinants of Health

### Methodology

This analysis aggregates tract-level indicators from multiple places within the Kenai Peninsula Borough (e.g., Western Cook Inlet, Nikiski, Kenai River, Kenai, Soldotna, Kalifornsky Beach, Kasilof, Ninilchik/Anchor Point, Diamond Ridge, Homer, East End Road, Kachemak Bay, Seward) to portray conditions for the broader region. Metrics are summarized using ranges (min–max) and qualitative patterns to reflect intra-regional diversity rather than a single average, because some indicators show extreme values in small or remote tracts that would be obscured by simple means. When a data point is unavailable for a tract (e.g., life expectancy in Western Cook Inlet), the gap is noted and the regional pattern is inferred from other tracts. Where helpful, national percentile rankings are cited to indicate relative burden (higher percentile ≈ higher risk/burden compared with U.S. tracts). All values and tract references come from the provided dataset.

### Regional context

- Population & age mix. Communities range from very small (≈200–1,000 residents) to mid-sized (≈4,000–7,500). Older adults make up a sizable share in several areas (e.g., 21–26% age 65+ in Kenai River, Ninilchik/Anchor Point, Homer), while family-age populations are higher in others (e.g., 25–26% age ≤17 in Kalifornsky Beach, East End Road). These age structures point to different health, mobility, and housing needs across the peninsula.
- Economic diversity. Poverty (<200% Federal Poverty Level (FPL)) spans ~15%–49% across tracts, with Western Cook Inlet at the high end. Unemployment ranges widely (~2.7%–16.8%), suggesting uneven labor markets and potential seasonality/volatility in some communities. Income inequality (GINI) varies from lower (0.31–0.39) to very high (0.51 in Kenai River), indicating pockets of concentrated advantage and disadvantage.
- Access to coverage & connectivity. Uninsured rates vary markedly (~9%–42%), with several tracts in the mid-teens but a critical outlier at 42% (Western Cook Inlet). Lack of internet access ranges ~6%–36%, which can impede telehealth, workforce participation, and emergency communications, especially in remote settings.

### Economic stability

- Poverty & unemployment: With poverty up to ~49% and unemployment up to ~16.8%, some communities face compounding risks—reduced capacity to absorb shocks (energy price spikes, disaster events) and fewer resources to invest in efficiency upgrades or health-protective measures. Where GINI is high (e.g., Kenai River 0.51), disparities may concentrate exposure and limit community-wide uptake of improvements without targeted support.
- Energy burden: Reported energy burden values range roughly 3–11 (with a 99th national percentile in Western Cook Inlet). High energy burden consumes household income that might otherwise cover healthcare, nutritious food, or housing maintenance—intensifying vulnerability to both health and environmental stressors.

## Education

- Educational attainment: “No high school diploma” ranges ~1.5%–10.9%. While most tracts fall mid-range, higher-need pockets (e.g., Kenai at 10.9%) may experience barriers to health literacy, employment opportunities, and utilization of incentive programs (e.g., for home energy upgrades), implying the need for accessible, plain-language outreach.

## Health care access & health status

- Uninsured & disability: Uninsured rates span ~9%–42%; disability prevalence ranges ~9.5%–24.1%. Communities with high disability and coverage gaps (e.g., Ninilchik/Anchor Point: disability 24.1%) are likely to benefit from local care coordination and accessible service design.
- Chronic disease & mental health: Hypertension (~8%–38%), diabetes (~0.4%–10.8%), asthma (~0.5%–10.8%), and poor mental health (~0.7%–13.8%) all show wide ranges. Several Southern Kenai tracts (e.g., Kachemak Bay; Ninilchik/Anchor Point; Kasilof) sit at notably high percentiles for multiple conditions, indicating elevated sensitivity to air quality, heat/cold stress, and disaster disruptions. Life expectancy is generally ~77–82 years where reported.

## Neighborhood & built environment

- Housing: Cost burden varies ~15%–40% (with Homer near 40%). Older/pre-1980 housing is high in some places (e.g., Western Cook Inlet ~85 occupied houses, 99th percentile nationally), which can correlate with inefficiency, indoor air issues, and resilience challenges. Mobile homes are a small-to-moderate share in several tracts (e.g., 13% in Nikiski). Median home values range from very low (Western Cook Inlet) to mid-\$300k (Hope/Cooper Landing, Diamond Ridge)—a signal of heterogeneous asset wealth and renovation feasibility.
- Environmental exposures: Most tracts show low diesel PM and air toxics percentiles; however, industrial proximity is higher in and around Kenai/Soldotna/Nikiski (e.g., hazardous sites counts and RMP facility proximity are elevated in Nikiski; hazardous sites counts are higher in Kenai and Soldotna). Such patterns may concentrate exposure concerns alongside employment hubs.
- Disaster & flood risk: Annualized disaster loss percentiles are high in many tracts (e.g., Kenai River 100th; Soldotna 99th; Seward 99th), and properties with flood risk range ~1%–25% (highest in Seward). These figures underscore the salience of coastal and riverine hazards across the borough.

## Transportation & access

- Transportation insecurity: Percentiles for transportation access suggest greater challenges in more rural/remote tracts (e.g., Hope/Cooper Landing ~92nd percentile; East End Road ~82nd), while cost burden percentiles also run high in a few areas (~80th–87th). Limited access can constrain employment, healthcare visits, and participation in weatherization or incentive programs that require travel. Traffic fatality rates vary from 0 to ~13 per 100,000.
- Digital access: Lack of internet access ranges ~6%–36%, with the highest share in Western Cook Inlet (~36%). This gap complicates outreach, enrollment, and emergency messaging.

## What these conditions mean (interpretation)

- High variability means uneven capacity to act. The borough contains communities with comparatively strong socioeconomic and health indicators alongside areas with high poverty, high uninsured rates, and limited access. Interventions, communications, and timelines will need to be differentiated by place, not one-size-fits-all.
- Energy affordability is a cross-cutting pressure. Even where health indicators are moderate, energy burden percentiles are high in several tracts, and exceptionally high in Western Cook Inlet. This reduces household bandwidth for preventive care, healthy food, and home upgrades—amplifying social and health vulnerabilities.



- Industrial adjacency vs. rural remoteness. Kenai/Soldotna/Nikiski show more industrial adjacency and traffic, while more remote tracts face long travel times and lower service density. Each pathway creates distinct exposure and access challenges that shape health outcomes and program reach.
- Disaster risk is broadly salient. With very high annualized disaster loss percentiles and notable flood-risk footprints (especially Seward and Kenai River), disaster resilience intersects directly with SDOH by threatening housing, livelihoods, and access to care—particularly for older adults and those with chronic disease.
- Coverage and connectivity gaps hinder uptake. Areas with high uninsured rates (up to ~42%) and limited internet access will need low-barrier, offline-friendly pathways into services to avoid widening inequities.

### Place Specific SDOH Flags

#### Cluster A — Northern Industrial Core

*Areas: Nikiski, Kenai, Soldotna, Kalifornsky Beach, Kenai River corridor*

##### Salient burdens

- Industrial and hazardous site proximity is elevated in parts of Nikiski/Kenai; traffic exposure higher along main corridors.
- Disaster-loss percentiles high to extreme in river adjacent tracts; flood risk present along Kenai River.
- Pockets of higher unemployment and income inequality (e.g., Kenai River corridor).
- Cost burden present for a meaningful share of renters/homeowners; older housing stock pockets persist.

##### Protective factors / strengths

- Regional employment hub; larger health, utilities, and retail anchors.
- Higher service density and road connectivity than rural West/Southwest.
- Midrange uninsured rates in many tracts; digital access moderately strong compared with remote areas.

#### Cluster B — Southern Homer Area

*Areas: City of Homer, Diamond Ridge, East End Road, Kachemak Bay*

##### Salient burdens

- Higher shares of older adults in several tracts; chronic disease percentiles (hypertension/diabetes/asthma) elevated in parts of Kachemak Bay and surrounding tracts.
- Housing cost burden notably high in Homer; some older housing stock.
- Transportation access challenges toward the East End; seasonal employment variability.

##### Protective factors / strengths

- Strong civic/health network in town; cultural and educational anchors; comparatively good digital access in town center.
- Community experience with resilience initiatives and volunteer networks.

#### Cluster C — Rural West & Remote

*Areas: Western Cook Inlet and nearby low density tracts*

##### Salient burdens

- Very high energy burden (national top percentile); highest uninsured and limited internet access.
- Small, dispersed population; limited road access and higher logistics costs.
- Older housing prevalence; limited local contractor base.

##### Protective factors / strengths

- Tight community networks; local knowledge; potential for shared facilities to act as anchor nodes.

**Cluster D — Central South & Coastal Highway Communities***Areas: Kasilof, Ninilchik/Anchor Point, Clam Gulch corridor*

Salient burdens

- Elevated disability prevalence in parts (e.g., Ninilchik/Anchor Point); chronic disease burden notable.
- Travel distance to service hubs; moderate uninsured; mixed digital access.
- Seasonal incomes and housing quality variation.

Protective factors / strengths

- Community organizations and tribal partners; highway access for mobile delivery.

**Cluster E — Eastern Gateways & Coastal Risk***Areas: Seward, Hope/Cooper Landing*

Salient burdens

- Very high disaster loss percentiles; flood and storm related risks significant (Seward highest share of properties with flood risk among the tracts).
- Transportation access challenges (esp. Hope/Cooper Landing) and seasonal traffic spikes.
- Mixed income and housing affordability pressures.

Protective factors / strengths

- Strong civic identity and emergency management experience; tourism economy provides institutional touchpoints.

**Intersection with Emissions Reduction Planning**

- Targeting & equity: Because poverty, energy burden, and uninsured rates cluster in specific tracts, pollution-reduction efforts that depend on upfront costs, complex enrollment, or sustained maintenance may under-serve high-need areas unless eligibility, financing, and outreach are calibrated to local conditions. Prioritization frameworks may need place-based weighting to reach Western Cook Inlet, Kachemak Bay, Ninilchik/Anchor Point, and other high-burden pockets.
- Health-protective co-benefits matter. Where chronic disease percentiles are high (e.g., hypertension, diabetes, asthma), reductions in indoor/outdoor air pollutants and improved thermal safety can yield disproportionate health benefits. Communicating these co-benefits may increase community support and participation among older adults and residents with disabilities.
- Resilience alignment: The high disaster-loss profile suggests that measures which also improve continuity of power, heat, and communications during outages will have outsized social returns—especially in tracts with high elderly shares, high flood risk, or long travel times.
- Access & delivery design: Remote and lower-connectivity tracts will benefit from mobile, hub-and-spoke, and offline-capable implementation models. Transportation insecurity percentiles and long travel distances imply that service models should minimize repeated trips and paperwork, and coordinate with local anchors.
- Housing stock realities: Older housing concentrations (e.g., Western Cook Inlet) and higher cost-burden areas (e.g., Homer) indicate that pre-work (repairs, health/safety remediation) may be necessary to unlock participation and avoid uneven uptake of pollution-reducing improvements.
- Industrial contexts: In and around Kenai/Soldotna/Nikiski—where hazardous-site proximity and traffic are higher—community trust, monitoring needs, and co-occurring exposures should inform sequencing and communications, to ensure local relevance and credibility.

**Bottom line**

The Kenai Peninsula Borough exhibits pronounced intra-regional diversity in economic security, health status, environmental risk, and access to services. Any sustainable energy roadmap for the borough will need to differentiate by place, explicitly account for high energy burdens and disaster risk, and design for coverage/connectivity gaps and mobility constraints—so that communities across the spectrum (from Western Cook Inlet to Kenai/Soldotna/Nikiski to Homer/Seward and the outlying tracts) can equitably realize health and resilience co-benefits as pollution falls.

## Mitigation Strategies

### Weatherization + clean heat for homes and small buildings.

Because stationary fuel use drives the footprint ( $\approx 71\%$  of total), and more than a quarter comes from the residential sector, the largest, fastest, and most widely distributed gains come from cutting heat demand and cleaning heat supply in homes. Pair deep weatherization (air sealing, insulation, ventilation/IAQ fixes) with fuel and equipment upgrades (e.g., high-efficiency appliances; targeted heat-pump adoption where feasible; efficient gas/oil equipment where not) to deliver immediate  $\text{MTCO}_2\text{e}$  reductions and household savings. This is especially impactful in at-risk tracts showing very high energy burden—e.g., Western Cook Inlet (energy burden  $\sim 11$ , national  $\sim 99$ th percentile) and parts of Kalifornsky Beach ( $\sim 95$ th)—and where household cost burden is already heavy (e.g., Kenai housing cost burden  $\sim 40\%$ ). Implementation should be offline-friendly and staged to include pre-work in older homes.

### Target large industrial heat loads and adjacent community benefits.

Industrial natural gas use alone accounts for roughly a quarter of total emissions, so focusing on a small number of large loads (process heat optimization, heat recovery, burner/boiler upgrades, and—where grid/supply allow—incremental electrification) can move totals faster than many diffuse actions. In and around the Northern Industrial Core (e.g., Kenai/Nikiski), pair technical upgrades with transparent monitoring and community engagement, given elevated proximity to hazardous and RMP-regulated facilities in some tracts. This framing both reduces  $\text{MTCO}_2\text{e}$  and supports better outcomes for nearby at-risk neighborhoods that experience combined cost, access, and exposure challenges.

### Truck-heavy transportation efficiency and fuels.

On-road transportation contributes  $\approx 29\%$  of emissions, with trucks responsible for nearly  $89\%$  of the on-road slice. Prioritize measures that bend that curve: coordinated fleet turnover (public + private), anti-idling and routing/telematics, right-sizing, and phased adoption of low-carbon fuels (e.g., drop-in blends) while building out charging where duty cycles fit early electrification. Target corridors and hubs in Cluster A (Kenai/Soldotna/Nikiski) and along the Sterling/Kenai Spur highways, and relieve transportation cost burdens that rank high in several tracts (e.g., Kenai area indicators). Co-benefits include noise/air quality improvements for neighborhoods with higher traffic fatality or access challenges.

### Resilience-first upgrades in flood/disaster-prone places.

Many tracts show very high annualized disaster loss percentiles (e.g., Kenai River at the 100th; East End Road in the mid-80s). Integrate mitigation with resilience by hardening building shells, elevating/relocating critical equipment, and prioritizing critical facilities and multi-family housing for backup-capable, cleaner systems (e.g., islandable configurations at clinics/schools, weather-ready controls). Doing the carbon work where hazard risk is greatest protects emissions gains during outages and advances outcomes for at-risk residents who face longer recovery times and higher disruption costs.

### Clean the kilowatt while electrifying where it pencils.

Electrification reduces emissions fastest when the kWh is cleaner or when efficiency cuts kWh use. The current upstream mix shows power largely from natural gas ( $\sim 55\%$ ) and petroleum ( $\sim 45\%$ ), with minimal hydro. Prioritize the “efficiency-first” kWh (building and industrial), negotiate or develop cleaner supply where feasible (e.g., PPAs, community-scale projects), and then electrify end uses with favorable duty cycles and lifecycle economics. This sequencing maximizes  $\text{MTCO}_2\text{e}$  impact and helps at-risk households—who often have the highest bills—see real savings rather than fuel-switch cost shifts.

### Improved Outcomes for Overburdened and Underserved Communities

Focusing mitigation where households spend the highest share of income on energy and where health burdens cluster delivers the biggest gains for at-risk communities. Weatherization plus cleaner heat cuts monthly bills and winter bill spikes, freeing cash for food, medicines, and repairs. Tighter, ventilated homes also reduce indoor pollutants from oil and unvented combustion, easing asthma and cardiovascular stress that track with high hypertension/diabetes rates in several tracts. When paired with simple, offline enrollment and pre-work for older homes, participation rises among residents who are uninsured, have limited internet, or face mobility barriers—turning programs that often miss at-risk communities into ones that measurably lower energy burden and improve indoor air quality.

Targeting large industrial heat loads near populated corridors (Kenai/Nikiski), truck-heavy corridors, and flood-prone zones (Kenai River, Seward) adds community-level benefits that at-risk residents feel first. Cleaner, quieter trucks and anti-idling reduce traffic-related air pollutants along busy routes; industrial upgrades with transparent monitoring build trust where facility proximity is highest; and resilience-first building improvements keep homes, clinics, and schools habitable during outages, cutting displacement days and recovery costs. Sequencing electrification with efficiency and cleaner supply ensures that low-income customers aren't trading one high bill for another—so emissions fall while affordability, health protection, and continuity of essential services rise together.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

#### Weatherization + Clean Heat for Homes & Small Buildings

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                          | Community Benefits                                                                                                         |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Residential is ~27.5% of community GHGs. A 20% reduction in residential fuel use → ~50 kt CO <sub>2</sub> e avoided; each 1% → ~2.5 kt. Deeper shells + heat-pump adoption in suitable homes compounds impact. | Directly lowers high energy-burden in at-risk tracts; makes future electrification more effective at lower operating cost. |
| Energy cost savings | High             | Typical whole-home weatherization can trim 15–30% heating load; space/water heat dominate bills. Paybacks quicker where oil/propane costs are high.                                                            | Largest bill relief where burden is highest; offline enrollment + pre-work raises resident participation.                  |
| Health benefits     | High             | Air sealing + balanced ventilation + clean heat reduce indoor PM/NO <sub>x</sub> → fewer asthma/CVD triggers; warmer, drier homes improve respiratory outcomes.                                                | At-risk tracts with higher chronic disease see largest health gains per dollar.                                            |
| Resilience          | Moderate–High    | Tight shells hold heat longer during outages; weather-ready controls and safe backup heat reduce displacement risk in cold snaps.                                                                              | Stabilizes conditions for medically vulnerable residents and elders.                                                       |
| Disbenefits / risks | Moderate         | Upfront costs; contractor shortage; winter heat-pump performance limits in some homes; landlord-tenant split incentives; need for electrical upgrades.                                                         | Without no-cost pathways, at-risk communities may be under-served; require pre-work allowances and consumer protections.   |



### Target Large Industrial Heat Loads (process optimization, heat recovery, burner/boiler upgrades)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                          | Community Benefits                                                                                                                           |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Industrial natural gas is ≈24% of total. A 10% cut in this slice → ~22 kt CO <sub>2</sub> e avoided; focused projects can move totals quickly. | Benefits extend to nearby communities in the Northern Industrial Core; fewer localized emissions co-occur with other community improvements. |
| Energy cost savings | High             | Process heat optimization and heat recovery typically yield double-digit fuel savings on large loads; strong ROI at scale.                     | Indirect; savings may support rate stability, jobs retention, or community benefits agreements.                                              |
| Health benefits     | Moderate         | Direct community health gains depend on co-pollutant reductions (NO <sub>x</sub> /PM) and site specifics; potential for improved local air.    | Prioritize facilities adjacent to at-risk neighborhoods for co-benefits and trust-building.                                                  |
| Resilience          | Moderate         | Thermal system reliability improvements reduce unplanned flaring/fuel spikes; potential to support critical services (steam/heat to campuses). | If paired with community benefit commitments (alerts, monitors), perceived resilience and safety increase for at-risk communities.           |
| Disbenefits / risks | Moderate         | Project complexity; downtime risk; capital cycles; stranded-asset concerns if deeper transitions follow; need for transparent monitoring.      | Without engagement, perceived benefits may bypass at-risk residents; ensure community input and grievance pathways.                          |



### Truck-Heavy Transportation Efficiency & Fuels (fleets, anti-idling, routing/telematics, phased low-carbon fuels, early EV where fit)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                               | Community Benefits                                                                                  |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Trucks ≈25.7% of total GHGs (≈89% of on-road). A 10% truck reduction → ~23.5 kt CO <sub>2</sub> e avoided; corridor-focused actions compound.       | Relief along busy routes near at-risk areas (noise/soot); prioritize depots for early benefits.     |
| Energy cost savings | Moderate–High    | Idling cuts, routing, and right-sizing can yield 5–15% fuel savings; early ZEVs pencil on predictable duty cycles; fuels hedging lowers volatility. | Lower goods-movement costs can stabilize prices; local workforce upskilling opportunities.          |
| Health benefits     | High             | Diesel NOx/PM reductions → near-road respiratory gains; fewer high-pollution micro-episodes from idling.                                            | Vulnerable populations near corridors sees disproportionate health improvements.                    |
| Resilience          | Moderate         | Fleet telematics improves winter operations; diversified fuels reduce supply shocks; roadside charging (where feasible) adds redundancy.            | Better emergency logistics/support to remote at-risk communities.                                   |
| Disbenefits / risks | Moderate         | Charging/fueling infrastructure gaps; winter range penalties; capital costs for small operators; policy acceptance.                                 | Risk that incentives flow to large fleets; earmark set-asides/TA for small risk-adjacent operators. |





### Resilience-First Upgrades in Flood/Disaster-Prone Places (hardening, elevating equipment, backup-capable systems)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                          | Community Benefits                                                                             |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Direct GHG impact modest; indirect preservation of savings by preventing damage to efficiency upgrades and avoiding rebuilding with higher-emitting equipment. | Keeps at-risk homes from losing prior improvements; avoids rebound to costlier backup fuels.   |
| Energy cost savings | Moderate         | Reduced damage and downtime lowers repair bills and temporary relocation costs; efficient backup reduces fuel spend during outages.                            | At-risk households face higher hardship from outages; resilience avoids catastrophic expenses. |
| Health benefits     | High             | Avoided displacement, safer thermal conditions, preserved refrigeration for meds/food; lower mold risk post-flood.                                             | Strongest gains for elders, disabled residents, and medically dependent populations.           |
| Resilience          | High             | Outage-tolerant buildings; islandable systems at clinics/schools; equipment above flood lines.                                                                 | Stabilizes essential services in at-risk areas; faster recovery.                               |
| Disbenefits / risks | Low–Moderate     | Upfront cost; siting constraints; maintenance of backup systems; potential noise from generators if not clean/quiet.                                           | Ensure noise/air standards and fuel access plans so at-risk community isn't burdened.          |



**Clean the kWh While Electrifying Where It Pencils (efficiency-first, then supply improvements, then end-use electrification)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                   | Community Benefits                                                                                                   |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Power mix is predominantly fossil; efficiency-first kWh cuts avoid upstream emissions immediately. End-use electrification yields larger GHG gains as supply cleans. Order-of-magnitude: each 1% kWh reduction in buildings trims several kt CO <sub>2</sub> e depending on sector mix. | Electrification after shell upgrades protects low-income customers from higher winter bills while cutting emissions. |
| Energy cost savings | Moderate         | Savings depend on relative fuel prices and tariffs; efficiency reliably lowers bills; electrification economics vary by home type and duty cycle.                                                                                                                                       | Pair with bill protections, rate design, and weatherization to ensure net savings for at-risk communities.           |
| Health benefits     | Moderate–High    | Reduces indoor combustion (NO <sub>x</sub> /CO), especially where oil/propane cooking/heating exists; improved IAQ plus lower drafts.                                                                                                                                                   | Bigger gains in at-risk homes with older appliances/heating.                                                         |
| Resilience          | Moderate         | Efficient, well-controlled electric systems can ride through short outages with smaller backup; load flexibility possible later.                                                                                                                                                        | With backup/hardening, electrified homes in at-risk areas avoid unsafe space-heating alternatives.                   |
| Disbenefits / risks | Moderate         | Grid capacity constraints; panel upgrades; winter performance; risk of bill increases if electrifying before envelope fixes or on unfavorable rates.                                                                                                                                    | Require no-cost upgrades, rate counseling, and staged sequencing to protect budgets.                                 |





### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower monthly energy burden and fewer winter bill spikes
- Health gains from cleaner indoor air (less NO<sub>x</sub>/PM) and warmer, drier homes
- Fewer near-road pollution exposures (anti-idling, cleaner trucks)
- Better outage resilience (backup-capable, weather-ready buildings)
- Reduced displacement and recovery costs after floods/storms
- Simpler, offline enrollment with navigators; higher participation/completion
- Local jobs and upskilling opportunities tied to installation and maintenance
- Trust and transparency via community monitoring and clear communications
- Consumer protections (pre-work/repairs, quality assurance) that prevent harm

Potential disbenefits if not designed equitably:

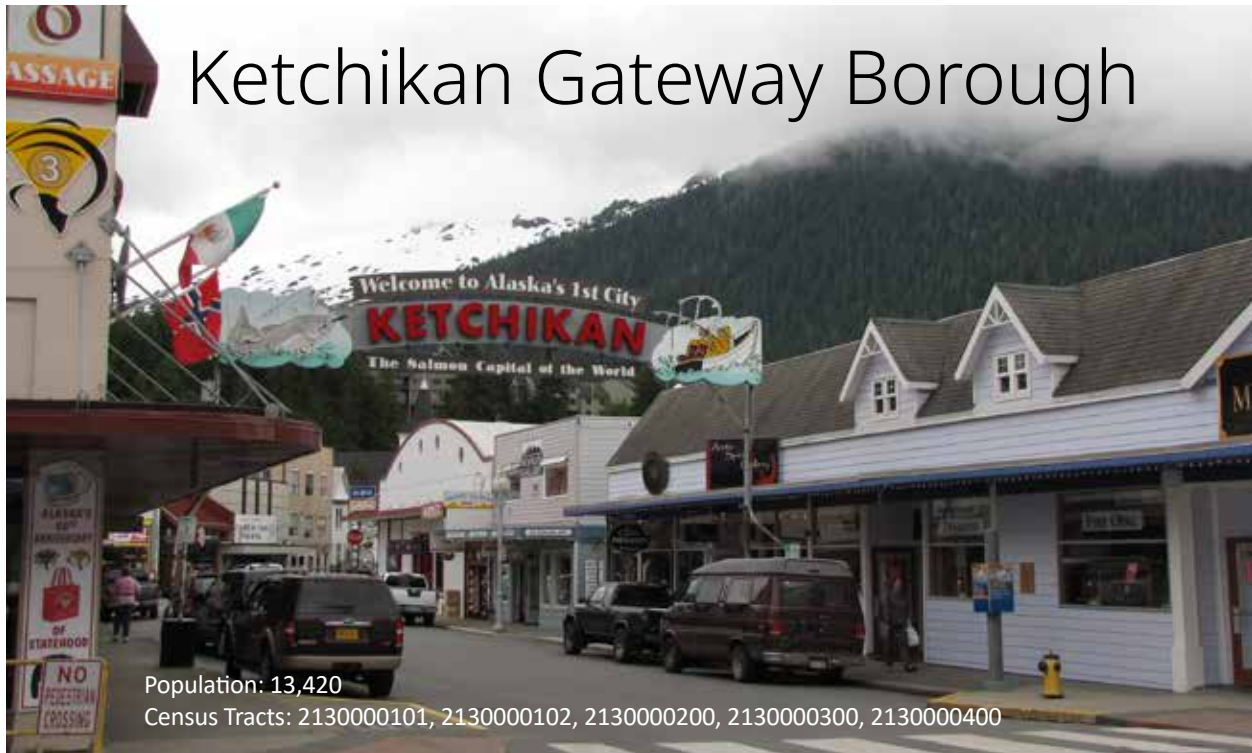
- Upfront costs and paperwork hurdles that screen out low-income households
- Risk of higher bills if electrification precedes envelope fixes or uses unfavorable rates
- Landlord–tenant split incentives; potential rent increases after upgrades
- Contractor capacity constraints, long wait times, and quality variability
- Temporary displacement during deep retrofits; accessibility barriers for elders/disabled
- Infrastructure siting burdens (noise/traffic/visuals) if not community-led
- Small fleet/operators struggling with capital for truck transitions
- Grid or panel upgrade needs; stranded-asset risk for certain fuel equipment
- Uneven incentive access if programs favor early adopters or large firms

### Path Forward

The Kenai Peninsula Borough's path to meaningful, durable emissions reduction is clear: focus where the emissions are largest and the community benefits are greatest. Pairing the SDOH profile with the emissions inventory points to three moves that do the most work—weatherization and clean heat in homes and small buildings, targeted upgrades to large industrial heat loads, and truck-focused efficiency and cleaner fuels along key corridors. These actions directly address the region's dominant stationary and transportation sources while improving affordability, indoor/outdoor air quality, and outage resilience.

Outcomes hinge on delivery. Implementation should be place-based and staged: start in higher-burden clusters, bundle pre-work for older homes, offer offline enrollment and navigator support, and coordinate with local anchors (tribal entities, clinics, schools, employers). For industrial and fleet measures, emphasize transparent monitoring, workforce upskilling, and access to capital for small operators so benefits land broadly. Track a concise set of metrics—tons reduced, changes in energy burden, health-proximate indicators near corridors/facilities, participation and completion by place, and resilience markers such as avoided displacement days. By pairing disciplined execution with attention to disparities, the borough can secure near-term emissions reductions and visible improvements in everyday well-being, while building a credible glidepath for deeper progress.





Ketchikan Gateway Borough's roadmap begins with a clear picture of local conditions and what they mean for sustainability action. Community health and household context vary sharply across tracts: older housing and renter concentrations in the core, flood-risk clusters near the waterfront, and transportation-access constraints even over short distances. These social determinants—paired with a bimodal age mix and notable rates of cost burden, disability, and chronic respiratory and cardiometabolic conditions—shape how residents experience energy use, air quality, and environmental risk day to day. On the emissions side, the profile is concentrated in two sources: on-road gasoline and diesel, and building heat from residual and distillate fuel oils; electricity's footprint is comparatively small due to hydro.

This roadmap translates those realities into practical mitigation moves that lower emissions while improving daily life. Using a community-scale roll-up across multiple census tracts, it pairs quantitative signals (emissions shares, fuel types, building vintage) with on-the-ground considerations (tenure, health, access) to identify where early investments can do the most good. The result is a focused set of strategies—home weatherization and heat-pump conversion, clean transportation with high-mileage fleet electrification and right-sized charging, commercial fuel-switching and controls, complemented by public-facility upgrades, port/airport electrification, and organics diversion—that can deliver measurable reductions, lower energy costs, cleaner air, and greater resilience for households and community assets.

### Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Weatherization + heat-pump conversion for homes (replace No.5 oil)
2. Clean transportation: high-mileage fleet electrification + right-sized charging
3. Commercial building fuel-switch and controls (replace No.1 distillate)

Together, these three moves directly target Ketchikan's biggest emitters—on-road gasoline/diesel and heating oils—covering ~100% of the community's major sources while leveraging a largely low-carbon (hydro) grid. They also deliver fast, visible co-benefits (lower bills, cleaner air, steadier indoor temps) in at-risk areas, making near-term progress both sizable and durable.

## Emissions Data Overview

Total Modeled Emissions: 58,143 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (48.12%)

- Residential Sector (33.32%)
  - Residual Fuel Oil No. 5: 17,172.17 mt CO<sub>2</sub>e (29.53% of total)
  - Natural Gas: 1,259.44 mt CO<sub>2</sub>e (2.17%)
  - Propane: 732.30 mt CO<sub>2</sub>e (1.26%)
  - Electricity: 176.60 mt CO<sub>2</sub>e (0.30%)
  - Wood & residuals: 35.28 mt CO<sub>2</sub>e (0.06%)
- Commercial Sector (12.81%)
  - Fuels: Distillate Fuel Oil No. 1: 7,839.30 mt CO<sub>2</sub>e (13.48%)
  - Propane: 598.45 mt CO<sub>2</sub>e (1.03%)
  - Electricity: 144.49 mt CO<sub>2</sub>e (0.25%)
  - Wood & residuals: 21.76 mt CO<sub>2</sub>e (0.04%)
- Industrial Sector (0%)

### Transportation (51.88%)

By fuel type:

- Motor Gasoline: 25,283.34 mt CO<sub>2</sub>e (43.49% of total)
- Diesel Fuel: 4,878.84 mt CO<sub>2</sub>e (8.39%)
- Electricity: 0.63 mt CO<sub>2</sub>e (negligible)

By vehicle type:

- Trucks: 26,177.03 mt CO<sub>2</sub>e (86.79% of transport emissions)
- Passenger vehicles: 3,956.91 mt CO<sub>2</sub>e (13.12%)
- Motorcycles: 28.87 mt CO<sub>2</sub>e (0.10%)

### Electricity Generation

- Electricity consumption: 2,234.16 MWh
- Generation sources:
  - Hydro: 1,117.08 → 0 mt CO<sub>2</sub>e
  - Petroleum: 1,117.08 → 321.72 mt CO<sub>2</sub>e (100%)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- Two buckets drive nearly all emissions: transportation (~52%) and building fuel use (~48%).
- Gasoline is #1. On-road motor gasoline alone is ~43% of total community emissions; diesel adds ~8%.
- Heating oil is #2. Residential residual fuel oil (No. 5) contributes ~30% of total; distillate (No. 1) in commercial adds ~13%.
- Electricity is a tiny slice. Thanks to hydro, electricity-related emissions are ~0.5% of the total; the petroleum share of generation accounts for virtually all electricity emissions.
- On-road is truck-heavy. Trucks account for ~87% of on-road emissions; passenger vehicles are ~13%; motorcycles are negligible.
- Gas & propane are minor contributors. Natural gas (~2.2%) and propane (~2.3% combined res/com) are small compared to gasoline and heating oils.
- Wood combustion is negligible (~0.1% combined).

Bottom line: Emissions are overwhelmingly tied to vehicle fuels and building heat, especially gasoline and heating oils; electricity's footprint is minimal.

## Social Determinants of Health

### Methodology

The profile aggregates tract-level indicators for Ward Cove/Clover Pass, Outer Ketchikan, Newtown, Downtown, and Saxman/Mountain Point to reflect conditions for the single community of Ketchikan. Where comparable percentages exist across tracts, population-weighted borough estimates are calculated to convey a community-wide baseline. To capture intra-community variation, ranges (min–max) and “hotspot” tracts are highlighted. Indicators that are only reported for some tracts are discussed qualitatively, with attention to spatial context (e.g., downtown/harbor adjacency, airport proximity). Percentiles are interpreted as relative burden versus U.S. tracts; higher percentiles indicate greater relative burden or exposure.

### Environmental & built environment

- Industrial and hazard proximity varies sharply by tract. Downtown is highly exposed to RMP facilities (89.6% of tract; 99th percentile) and has the highest hazardous-site proximity (81st percentile), while Newtown is also elevated (RMP 22.5%; 90th percentile). Saxman/Mountain Point is moderately elevated (RMP 2.5%; 84th percentile). Outer Ketchikan shows low-to-moderate proximity (RMP 0.02; 69th percentile).
- Flood risk clusters in the core. Downtown has 20% of properties with flood risk (85th percentile); Newtown 6% (45th); Saxman/Mountain Point 11% (66th).
- Older housing stock is concentrated downtown and Newtown. Pre-1980s housing is very high downtown (76.2; 95th percentile) and high in Newtown (62.2; 86th); Saxman/Mountain Point is elevated (45.2; 68th).
- Airport adjacency is universal in core tracts. Newtown and Downtown are 100% airport-adjacent (97–93rd percentiles), which may coincide with port/harbor activity.

Implications: Prioritize health-protective, non-displacing improvements in older rental buildings and flood-prone corridors; consider port/airport adjacency when sequencing local emission-reducing measures; pair any industrial-adjacent actions with risk communication for residents and workers in Downtown/Newtown. (Data above.)

### Health status

- Chronic conditions show tract hotspots. Downtown has the highest asthma (5.07%), poor mental health (7.26%), and high blood pressure (15.6%); Newtown is moderate; Saxman/Mountain Point is lower than the core.
- Life expectancy is generally solid but varies. Downtown averages 80 years; Saxman/Mountain Point 81; Newtown 77.4 with higher “low life expectancy” percentile (60th).
- Disability prevalence is substantial. Peaks around 16–16.7% in Saxman/Mountain Point and Newtown; downtown ~14.4%.

Implications: Health co-benefits (e.g., indoor air quality, thermal comfort, moisture/mold mitigation) will be most salient downtown; accessible program delivery is important borough-wide given disability shares. Addressing stressors tied to housing/energy costs can indirectly improve mental and cardiometabolic health.

### Socioeconomic conditions

- Poverty and cost burden concentrate downtown/Newtown. Downtown has 31.4% under 200% Federal Poverty Level (FPL) and 39.7% housing cost burden; Newtown is similarly high (27.1% FPL; 38.0% cost burden). Saxman/Mountain Point is moderate (16.1%; 28.0%).
- Renters are concentrated in the core. Downtown 53.9% renters; Newtown 41.8%; Saxman/Mountain Point 18.0%.



- Insurance and internet gaps elevate access barriers. Uninsured rate peaks downtown (13.1%) and is moderate in Newtown (9.3%); lack of internet is 15.9% downtown and 14% in Newtown.
- Inequality is highest downtown/Newtown. Gini index 0.47 downtown; 0.44 Newtown—well above Ward Cove/Clover Pass ~0.37.

Implications: CPR programs should include affordability guardrails, tenant protections, and non-digital outreach in core tracts to ensure low-income and renter households can participate and benefit. Vary incentives and delivery models across tracts to reflect different tenure and income patterns. (Data above.)

### Transportation & access

- High transportation insecurity across tracts. Percentiles are elevated: Downtown 88th, Newtown 90th, Outer Ketchikan 99th (highest constraints), Ward Cove/Clover Pass 98th (approx., Access Score 1.03–1.16 range across tracts).
- Transportation cost burden ranges from moderate to high. Downtown 0.17 (81st percentile), Newtown 0.13 (45th), Outer Ketchikan 0.11 (27th).
- Traffic fatalities are low–moderate. Downtown 1.77/100k, Newtown 1.23, Outer Ketchikan 1.04; Ward Cove/Clover Pass 0.00.

Implications: Outreach and service models should not rely solely on fixed-site or digital enrollment; expect last-mile and schedule barriers, especially in Outer Ketchikan and core renter areas. When planning CPR actions that interact with mobility (e.g., access to program sites, equipment delivery/installation logistics), build in transportation supports to avoid inequitable uptake

### Intersection with Emissions Reduction Planning

- Where to start and who's most affected: Downtown and Newtown show stacked stressors—higher poverty, renter concentration, older housing, industrial/flood proximity—while Outer Ketchikan faces connectivity and service-access challenges. Early phases should steer more benefits toward residents experiencing the greatest combined household, housing, and environmental pressures, and tailor participation paths for rural/low-density areas.
- Housing vintage & renter dynamics: Large shares of pre-1960/1980 buildings and high renter occupancy mean programs must anticipate split incentives, electrical and envelope upgrades, and moisture/mold remediation—delivering improvements without pushing up housing costs or displacement risk.
- Health co-benefits and exposure reduction: With asthma/mental-health hotspots downtown and widespread cardiometabolic conditions, measures that cut indoor pollution, dampen temperature swings, and lower energy stress can yield meaningful health gains while reducing local combustion near homes and workplaces.
- Flood risk & critical facilities: Flood-prone areas in the core, plus adjacency to airport/port operations, call for plans that reduce emissions and also keep essential services running during extreme events—especially where renters and small businesses cluster.
- Household affordability: With sizeable housing cost burden and notable uninsured rates, design program features that keep upfront costs low, simplify enrollment, and protect renters from pass-through costs; bundle energy, comfort, and health benefits to reduce overall cost of living.
- Access & participation logistics: High transportation-insecurity percentiles and internet gaps suggest outreach can't rely solely on online portals or centralized sites. Use mobile sign-ups, local partners, flexible scheduling, and multilingual materials so residents across tracts can enroll and complete projects.
- Age- and ability-inclusive delivery: With significant shares of seniors, youth, and residents with disabilities, ensure offerings and installations are accessible, safe, and coordinated with schools, senior centers, and in-home support services so benefits reach people with mobility or health limitations.

**Bottom line**

Ketchikan’s community-wide averages mask sharp intra-community disparities, with Downtown/Newtown facing layered economic, housing, and environmental burdens and Outer Ketchikan facing pronounced access/connectivity challenges. These patterns should guide where CPR benefits are concentrated, how programs are delivered (tenure-aware, accessibility-forward), and which co-benefits (health, affordability, resilience) are emphasized—so that emissions pollution reduction meaningfully improves health and equity across the whole community.

**Mitigation Strategies****Weatherization + heat-pump conversion for homes (start in hydro-served areas)**

Ketchikan’s electricity is largely hydro, while a big slice of community emissions comes from heating oils in homes. A borough program that couples deep envelope upgrades (air-sealing, insulation, ventilation, moisture control) with cold-climate heat pumps will cut fuel oil use, stabilize indoor temperatures, and reduce asthma/respiratory triggers tied to older housing. Target initial offerings to Downtown/Newtown blocks with the highest renter share, layering tenant protections (no rent hikes tied to upgrades), landlord incentives for multi-unit buildings, and in-home support for seniors and residents with disabilities. Pair rebates with no-cost audits and “make-ready” electrical work so at-risk households can participate without upfront costs. This aligns with existing Alaska pathways (AHFC weatherization; Southeast “beneficial electrification”) that can be scaled locally.

**Public facilities retrofits & beneficial electrification (schools, city assets, water/wastewater)**

Public buildings are large, predictable energy users—and upgrades here deliver fast, visible savings. Prioritize school and borough facilities for recommissioning, envelope fixes, high-efficiency heat and hot-water (including heat pumps where grid capacity allows), and controls. In flood-prone downtown corridors, add resilience co-measures (elevated equipment, flood-tolerant materials) so upgrades endure. Wastewater plants and similar facilities are prime early movers for fuel-switching to electric or heat-recovery systems, cutting local combustion near neighborhoods while improving air quality. Savings can be redirected to services at-risk residents use most (schools, transit, clinics), and projects create local trades work the workforce system is already gearing up to deliver.

**Port shore power & clean harbor/airport zones**

Because many residents live and work near the waterfront, electrifying ship hoteling (shore power) and accelerating clean cargo-handling equipment can materially lower on-the-ground exposure to combustion emissions where people congregate. Prioritize docks and adjacent streets that abut dense renter blocks and small businesses so at-risk neighborhoods experience earlier air-quality gains and reduced noise. At the airport/harbor interface, add idle-reduction policies and incentives for electric ground service equipment, supported by make-ready electrical upgrades. These actions complement Southeast’s emerging “green corridor” work and leverage Ketchikan’s hydro to displace petroleum at the fence line.

**Clean transportation access: EV charging + practical, low-cost mobility**

Transportation is roughly half the footprint—and access constraints are high even over short distances. Build out a right-sized EV charging network (mix of Level 2 at homes/workplaces and a few public DC fast chargers) to enable private and fleet electrification, focusing first on at-risk blocks with low home-charging feasibility (renters, older wiring). Pair this with low-cost mobility steps that matter locally: reliable micro-transit or demand-response service to job/clinic hubs, e-bike and adaptive-bike programs for hilly routes, and safe routes for students and seniors. For municipal and commercial fleets, start with the highest-mileage units (light-duty and service vehicles) to maximize fuel savings; give small contractors a pathway to participate through pooled procurement and depot charging.

### Organics diversion & local composting (cut methane, lower hauling costs)

Diverting food scraps, yard waste, and cardboard from disposal avoids methane, reduces costly hauling, and yields local soil inputs for community gardens and tribal food projects. A hub-and-spoke composting model—anchored by a centralized site and neighborhood drop-offs—can be stood up quickly with clear operating procedures, community training, and co-siting near existing public works yards. Prioritize service to multi-unit buildings and small businesses downtown so at-risk households see lower trash bills and cleaner alleys, and reinvest avoided disposal costs into expanding service to outlying areas. This approach is already being advanced by Southeast partners and can scale regionally.

### Improved Outcomes for Overburdened and Underserved Communities

Investing first in the places where residents face the greatest combined housing, health, and access pressures can deliver faster, more meaningful gains. Weatherization plus heat-pump conversions in older rentals and small homes reduce fuel-oil use and monthly bills, improve indoor air quality and thermal comfort, and lower mold/moisture risk—benefits that matter for households with asthma, cardiometabolic conditions, and fixed incomes. Pairing these upgrades with no-cost audits, make-ready electrical work, and protections against rent pass-throughs helps ensure participation and keeps savings with the people paying the bills. Public-facility retrofits (schools, clinics, community centers, water/wastewater) cut local combustion where many at-risk residents learn, receive care, and gather—improving indoor environments while freeing operating dollars that can be redirected to services.

Clean transportation actions further compound benefits. Shore power and cleaner equipment at the port/airport reduce on-the-ground exposure to combustion emissions in waterfront neighborhoods, while a right-sized EV-charging network and practical, low-cost mobility (micro-transit, e-bikes/adaptive bikes, safer routes) make it easier for at-risk residents to access jobs, school, and appointments. Early electrification of high-mileage municipal and service vehicles can cut noise and tailpipe pollution on streets that run through renter-dense blocks. Finally, organics diversion lowers alley odors and pests around multi-unit buildings, reduces hauling costs on tight household budgets, and supports local food and soil projects. Taken together, these moves reduce energy burden, improve day-to-day air quality and comfort, increase resilience in flood-prone areas, and open pathways to local jobs and training—tangible outcomes that build trust and momentum for the broader emissions reduction plan.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Weatherization + Heat-Pump Conversion (Homes)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                  | Community Benefits                                                                                                   |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Residential heating oils account for ~30% of total emissions. Converting 20–40% of oil-heated homes with envelope upgrades + cold-climate heat pumps could reduce ~6–12% of community-wide emissions in the near term, with higher long-run potential. | Focus on older rentals/ small homes in core tracts; early, visible reductions where fuel oil use is concentrated.    |
| Energy cost savings | High             | Typical households switching from No. 5/No. 1 oil to efficient heat pumps plus insulation realize sizable bill cuts; scale depends on building condition and electric rates. Savings are durable with good weatherization.                             | Reduces energy burden; pair with no-cost audits, make-ready electrical work, and rent-increase protections.          |
| Health benefits     | High             | Better IAQ, fewer combustion byproducts, improved thermal comfort, moisture/mold mitigation—especially impactful in older housing.                                                                                                                     | Targeted improvements in renter-dense blocks with higher asthma/mental-health indicators.                            |
| Resilience          | Moderate–High    | Weatherized homes maintain safe temperatures during outages; heat pumps paired with backup heat/controls add robustness.                                                                                                                               | Benefits seniors, people with disabilities, and households with limited mobility.                                    |
| Disbenefits/risks   | Moderate         | Upfront costs; contractor capacity; landlord-tenant split incentives; possible rent pass-through without safeguards; cold-weather performance if poorly sized.                                                                                         | Mitigate via tenant protections, direct-to-tenant offers, quality-assurance, and workforce support in at-risk areas. |





**Public Facilities Retrofits & Beneficial Electrification (Schools, City Assets, Water/Wastewater)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                               | Community Benefits                                                                |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Public buildings are a modest slice of community totals but large users locally; aggressive retrofits could deliver ~1–3% community-wide reduction near term, plus ongoing savings. | Improvements in places at-risk residents learn, receive care, and gather.         |
| Energy cost savings | High             | Portfolio-level savings from controls, envelope fixes, and heat electrification free operating dollars for services.                                                                | Savings can stabilize services relied on by schools, clinics, and transit hubs.   |
| Health benefits     | High             | Better IAQ/thermal comfort in schools and civic buildings; reduced local combustion near neighborhoods.                                                                             | Direct benefits for students, elders, and staff using these facilities daily.     |
| Resilience          | High             | Resilient retrofits (elevated equipment in flood-prone areas, backup power integration) protect critical services.                                                                  | Keeps essential services available during disruptions in at-risk neighborhoods.   |
| Disbenefits/risks   | Low–Moderate     | Capital intensity; construction disruption; grid capacity at specific sites.                                                                                                        | Sequence projects to avoid service interruptions in community-serving facilities. |

**Port Shore Power & Clean Harbor/Airport Zones**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                 | Community Benefits                                                                               |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Depends on ship calls and connection rates; with strong uptake, shore power and electric cargo/ground equipment could deliver ~1–5% community reduction and larger local NOx/PM cuts. | Many at-risk residents live/work near the waterfront; benefits accrue where exposure is highest. |
| Energy cost savings | Moderate         | Operators can reduce fuel spend and maintenance; economics hinge on tariffs and utilization.                                                                                          | Savings can support steady employment and reduced noise near at-risk blocks.                     |
| Health benefits     | High             | Substantial local air-quality gains (diesel PM, noise) at the fence line.                                                                                                             | Immediate exposure reductions for nearby at-risk residents and workers.                          |
| Resilience          | Moderate         | Modernized electrical infrastructure and idle-reduction improve operations during events; power redundancy matters.                                                                   | Keeps economic hubs functioning that serve at-risk employment and services.                      |
| Disbenefits/risks   | Moderate         | High capital costs (make-ready, substations), alignment with ship schedules/standards; local construction impacts.                                                                    | Coordinate construction windows and community communication in adjacent at-risk areas.           |

**Clean Transportation Access (EV Charging, Practical Low-Cost Mobility, Fleet Electrification)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                            | Community Benefits                                                                                                             |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | On-road fuels are ~51–52% of total (gasoline ~43%, diesel ~8%). Near-term electrification of municipal/commercial high-mileage vehicles + early personal EV adoption can yield ~5–15% community-wide reductions, with larger long-run potential. | Prioritize chargers and mobility services where home charging is hard (renters, older wiring) and access barriers are highest. |
| Energy cost savings | High             | Fleet TCO savings and lower per-mile energy costs; household fuel savings rise with mileage.                                                                                                                                                     | Helps at-risk households and small businesses facing transportation cost pressure.                                             |
| Health benefits     | High             | Less tailpipe pollution along busy corridors; quieter streets.                                                                                                                                                                                   | Benefits at-risk neighborhoods with heavier traffic exposure.                                                                  |
| Resilience          | Moderate         | Distributed charging with managed load can aid reliability; mobility options (micro-transit, e-bikes) provide redundancy.                                                                                                                        | Improves access to jobs/clinics for at-risk residents during service disruptions.                                              |
| Disbenefits/risks   | Moderate         | Upfront vehicle costs; charging access for renters; range/charger availability concerns; grid upgrades at depots.                                                                                                                                | Address with targeted incentives, shared charging, depot make-ready, and consumer protections.                                 |

**Organics Diversion & Local Composting**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                         | Community Benefits                                                                                                |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate     | Methane avoidance can be meaningful per ton, but total share is likely <1–2% of community emissions in the near term until full waste streams are quantified. | Early service for multi-unit buildings and small businesses reduces alley issues and fees for at-risk households. |
| Energy cost savings | Low–Moderate     | Potential reductions in hauling/disposal costs and avoided landfill fees over time.                                                                           | Can lower monthly trash bills for at-risk participants; supports local soil/food projects.                        |
| Health benefits     | Moderate         | Fewer odors/pests around dumpsters; cleaner alleys; modest air-quality gains from reduced hauling.                                                            | Improves daily living conditions in dense at-risk blocks.                                                         |
| Resilience          | Moderate         | Local soil amendments support community gardens and stormwater infiltration; diversifies waste management.                                                    | Strengthens neighborhood-scale food and green-space efforts serving at-risk.                                      |
| Disbenefits/risks   | Low–Moderate     | Contamination risk, odors if mismanaged; siting and operations need care; behavior-change effort.                                                             | Provide education, clean-site design, and reliable collection where language/access barriers exist.               |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower monthly energy costs from weatherization, heat pumps, and efficient equipment
- Cleaner indoor air and steadier temperatures in older homes; fewer moisture/mold issues
- Reduced on-street pollution and noise near homes, schools, and clinics (fleet/port electrification)
- Better access to services via micro-transit, e-bikes, and right-sized EV charging in renter areas
- More reliable public facilities (schools, water/wastewater) during disruptions and floods
- Safer, quieter streets from fewer tailpipe emissions and idling
- Local job and training pathways in construction, electrical, and maintenance trades
- Lower trash fees/cleaner alleys in multi-unit buildings with organics diversion
- Easier enrollment when paired with no-cost audits, multilingual outreach, and in-home support
- Greater day-to-day comfort and health for seniors, people with disabilities, and families with kids

Potential disbenefits if not designed equitably:

- Rent increases or pass-through costs after building upgrades if protections are weak
- Upfront costs or financing hurdles for households and small businesses
- Access barriers (no car, limited internet, limited time off) that depress participation
- Construction disruptions, noise, and temporary loss of services during retrofits
- Limited contractor capacity or poor quality control leading to underperforming projects
- Grid constraints at ports, depots, or neighborhoods that delay electrification benefits
- Regressive incentive designs that favor high-income adopters over at-risk participants
- Higher electricity bills if fuel switching isn't paired with good weatherization/controls
- Siting concerns (e.g., chargers, compost hubs, substations) without community input
- Technology fit risks (cold-weather heat pump sizing, charger reliability) and maintenance gaps

### Path Forward

Ketchikan Gateway Borough is positioned to cut emissions where it matters most—on-road fuels and building heat—while improving daily conditions for residents. The analysis points to a practical first wave: weatherization with heat-pump conversions for homes that currently rely on heating oils; high-mileage fleet electrification supported by right-sized public and depot charging; and commercial fuel-switching with controls and recommissioning. Public-facility retrofits, shore power and cleaner harbor/airport equipment, and organics diversion round out a portfolio that also delivers cleaner air, steadier indoor temperatures, and lower household and municipal energy costs.

The path forward should focus on sequencing, delivery, and proof of impact. In the next 6–12 months, launch targeted pilots in renter-dense and flood-prone downtown corridors and along high-traffic routes: bundle no-cost audits, make-ready electrical work, and tenant protections for residential upgrades; prepare depot and workplace charging for municipal and service fleets; and initiate recommissioning in schools and critical facilities. In parallel, set up enabling pieces—contractor training and QA, simple incentive menus for small businesses, community-based outreach with multilingual materials, and a streamlined application that does not assume home charging or reliable internet.

Over the following 2–3 years, scale what works: expand residential conversions block-by-block, electrify additional fleet segments, and move port/airport projects from design to operation as grid upgrades come online. Track outcomes with a concise dashboard—tons CO<sub>2</sub>e reduced, homes weatherized/converted, fleet miles electrified, indoor air/comfort metrics in retrofitted buildings, and participation by at-risk households and businesses—and use those results to refine program design and meet EPA reporting needs. By pairing visible community benefits with disciplined measurement and steady capacity building, Ketchikan can deliver durable emissions cuts and everyday improvements residents feel at home, at work, and on the street.

# Kodiak Island Borough

Population: 12,570

Census Tracts: 2150000100, 2150000200, 2150000300, 2150000400, 2150000500

Kodiak Island Borough faces a distinctive mix of energy, health, and environmental realities shaped by its maritime location, older housing stock, renter-heavy submarkets, language access needs, and exposure to extreme weather. A preliminary 2022 emissions profile indicates that community-scale criteria pollutants and greenhouse gas emissions are driven primarily by residential heating with fuel oil and on-road gasoline use, while hydropower keeps electricity-related emissions comparatively low. These conditions intersect with social determinants of health—especially energy burden, indoor air quality, access to services, and disaster readiness—creating a strong case for measures that lower emissions and improve day-to-day wellbeing.

This roadmap integrates multiple census tracts to describe conditions across the community as a whole, combining census area metrics with tract-level variation to capture minimum/median/maximum ranges where relevant. The analysis foregrounds improved outcomes for at-risk communities and uses qualitative and quantitative evidence to compare benefits and risks. The goal is to surface the most impactful strategies for near-term emissions reduction and co-benefits, set clear expectations for cost and health gains, and lay a practical foundation for the State’s sustainable energy action planning—without pre-judging specific program designs or delivery pathways that will be developed in subsequent steps.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Weatherization + clean heat in homes (oil-to-heat-pump where feasible)
2. Deep efficiency + electrification in public/commercial buildings
3. Transportation electrification (focus on gasoline displacement and equitable electric vehicle (EV) charging stations)

These strategies target Kodiak’s biggest emitters—residential heating oil and on-road gasoline—so each project delivers outsized CO<sub>2</sub>e cuts, especially with a largely hydro-powered grid. They also stack benefits residents feel immediately: lower bills, healthier indoor air, and better outage resilience, with early gains for at-risk households. Plus, they’re fundable and ready to scale using proven tech and programs, with clear metrics to track progress and well-understood design standards that keep risks manageable.



## Emissions Data Overview

Total Modeled Emissions: 107,965 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (58.92%)

- Residential Sector (44.83%)
  - Residual Fuel Oil No. 5 43,227.40 mt CO<sub>2</sub>e (40.04% of community).
  - Natural gas: 3,812.99 mt CO<sub>2</sub>e (3.53%).
  - Propane: 654.9 mt CO<sub>2</sub>e (0.61%).
  - Electricity : 602.73 mt CO<sub>2</sub>e (0.56%).
  - Wood & wood residuals: 131.51 mt CO<sub>2</sub>e (0.1%).
- Commercial Sector (14.08%)
  - Distillate Fuel Oil No. 1: 13,479.36 mt CO<sub>2</sub>e (12.48%).
  - Propane: 1,029.00 mt CO<sub>2</sub>e (0.95%).
  - Wood & wood residuals: 37.41 mt CO<sub>2</sub>e (0.03%).
  - Electricity: 660.70 mt CO<sub>2</sub>e (0.61%)
- Industrial Sector (0%)

### Transportation (41.08%)

By fuel type:

- Motor gasoline: 34,032.38 mt CO<sub>2</sub>e (31.52% of community).
- Diesel fuel: 8,260.56 mt CO<sub>2</sub>e (7.65%).
- Electricity: 6.19 mt CO<sub>2</sub>e (0.01%).

By vehicle type (within transport):

- Trucks: 37,503.62 mt CO<sub>2</sub>e (84.55% of transport emissions)
- Passenger vehicles: 4,750.97 mt CO<sub>2</sub>e (10.71%)
- Motorcycles: 44.54 mt CO<sub>2</sub>e (0.1%)

### Electricity Generation

- Electricity consumption: 7,600.68 MWh
- Generation sources:
  - Hydro 3,192.29 → 0 mt CO<sub>2</sub>e
  - Petroleum 4,408.39 → 1,269.62 mt CO<sub>2</sub>e (100%)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- Homes drive the footprint. Stationary combustion is the largest slice, and the residential sector dominates within it.
- Heavy reliance on heating oil. Residual/No. 5 fuel oil in homes is the single biggest source, dwarfing propane, wood, and building electricity.
- Transport is the clear #2. Gasoline leads transportation emissions, followed by diesel; a small share is from aviation and an almost negligible share from EV charging.
- Electric power is mostly clean on-site. Local hydropower keeps electricity-related CO<sub>2</sub>e low; the petroleum share of generation accounts for nearly all electricity emissions.
- Commercial fuel use is meaningful but secondary. Commercial heating—primarily distillate fuel oil No. 1—is the next notable stationary contributor.
- Industrial and process sources are minimal in this cut. Non-energy categories (waste, industrial processes, ag/land-use) are near-zero or not material in this preliminary profile.
- Overall scale. Community total is on the order of ~108k metric tons CO<sub>2</sub>e, with a roughly 60/40 split between stationary (mostly residential heat) and transportation.

**Bottom line:** Kodiak’s emissions picture is defined by household heating with oil and on-road gasoline use, while a largely hydro-powered grid keeps electricity-related emissions relatively low.

## Social Determinants of Health

### Methodology

The analysis aggregates five census tracts within the Kodiak Island Borough (Kodiak Island, East Kodiak, West Kodiak, Kodiak–Channel, and Kodiak Station) to reflect one community. Percentages and rates were combined using population-weighted averages to characterize borough-level conditions, while min/median/max values highlight within-community variation. National percentile fields are treated as relative position vs. the U.S. (higher = more exposed/vulnerable relative to peers).

### Environmental & built environment

- **Exposure & risk profile** (varied but elevated overall): Anticipated changes in extreme weather range from 30.7 → 85.2 (median ≈ 72), with a population-weighted average ≈ 68th percentile, indicating above-average extreme weather event exposure across much of the borough. Annualized disaster loss is also elevated on average (weighted ≈ 74th percentile) with tract-level loss values in the \$0.41–\$2.73M range.
- **Industrial and hazard proximities** (localized hotspots): Risk Management Plan (RMP) facility proximity spans 0% → 81% of tract area (median ≈ 1.5%), with the Kodiak–Channel tract registering 98th national percentile. Hazardous site proximity varies widely (0 → 39.5 nearby tracts; median ≈ 7.6). These patterns point to neighborhood-level disparities in environmental risk.
- **Legacy housing & federal lands:** Older housing is prominent in some locations (e.g., pre-1980s shares highest in Kodiak–Channel and West Kodiak), increasing potential for housing-related exposures and energy inefficiency. Several tracts include Formerly Used Defense Sites (FUDS).
- **Mobility infrastructure & flood:** Airport proximity is extensive in East Kodiak and Kodiak–Channel (≈ 100% of tract area), reflecting unique exposure and noise/air considerations. Flood risk is low in most tracts but reaches 9% of local properties in the Kodiak Island tract (≈ 61st national percentile).

**Overall implications:** Environmental conditions suggest an environmentally-exposed maritime community with localized industrial/hazard proximities and older housing concentrations. These factors can amplify health risks during extreme events and interact with housing quality, energy needs, and emergency planning.

### Health status

- **Respiratory & chronic disease burden:** Borough-level (weighted) estimates indicate asthma ≈ 7.5%, diabetes ≈ 6.1%, and high blood pressure ≈ 22.6%. Variation is substantial: diabetes spans 2.0% → 9.7%, and hypertension 8.7% → 30.6%, with West Kodiak showing higher cardiometabolic burdens.
- **Mental health:** Weighted prevalence of poor mental health ≈ 10.5%, with notable highs in Kodiak Station (13.8%). This aligns with known stressors in remote, seasonal, and industrial economies where affordability, isolation, and shift work can interact.
- **Longevity** (mixed and data gaps): Available tracts report life expectancy around 79–81.6 years; some tracts list 0.00 (data not available), underscoring the need to close measurement gaps when planning.

**Overall implications:** Chronic cardiometabolic risks and mental health needs are present alongside respiratory concerns. Health system access and continuity of care will matter during environment-related disruptions (e.g., storm-related outages or supply delays).

### Socioeconomic context

- **Economic precarity & affordability:** About 20.3% of residents live under 200% Federal Poverty Level (FPL) (weighted), but tract shares range 13.0% → 32.2%. Uninsured rates average ≈ 16.4% borough-wide, with a high 25.2% in the Kodiak Island tract, increasing vulnerability to untreated conditions and financial strain. Housing cost burden is uneven, rising to 35.8–40.8% in West Kodiak and Kodiak–Channel.

- Education & work: No HS diploma levels range 2.4% → 15.7% with national percentiles often in the 80s–90s, signaling skill and wage headwinds for segments of the community. Unemployment varies widely (0% → 7.6%), reflecting seasonal dynamics and tract-specific economies.
- Housing tenure & quality: Rentership ranges from 23% → 99%, highest at Kodiak Station and Kodiak–Channel, which can limit household control over efficiency upgrades and resilience retrofits. Older housing (pre-1960s/1980s) is concentrated in Kodiak–Channel and West Kodiak, relevant to energy and health outcomes.
- Energy & utilities: Energy burden averages ≈3–5% (weighted ≈ 3.4%; tract max 5%), but national percentiles are high in places (e.g., 89th in the Kodiak Island tract), signaling relative affordability challenges compared with U.S. peers. Internet gaps reach 28.5% in Kodiak–Channel, affecting access to telehealth, education, and emergency info.
- Language & demographics: Limited English proficiency (LEP) varies dramatically (0.07% → 17.1%), peaking in West Kodiak (100th national percentile). Age structure is bimodal with older concentrations in Kodiak–Channel (30% 65+) and youth concentrations in Kodiak Station (≈37% under 17).

Overall implications: Socioeconomic conditions point to affordability, coverage, language access, and renter-dominated clusters—all of which shape who benefits from programs and how quickly households can act on recommendations.

### Transportation access, safety, and costs

- Access & costs: Transportation access percentiles are generally above the national median (e.g., ≈53rd–83rd by tract), indicating moderate access challenges for a rural island setting. Transportation cost burden clusters around 0.12–0.14 of household budgets.
- Safety: Traffic fatalities are zero in most tracts, with an outlier 1.16 per 100,000 in East Kodiak.

Overall implications: Geographic isolation and ferry/air dependencies can constrain access to services, supplies, and emergency evacuation, and raise program delivery costs—even where on-road safety outcomes are strong.

### Intersection with Emissions Reduction Planning

- Household energy burden & retrofit potential. Energy burden is elevated in several tracts (e.g., 5.0; 89th percentile; others at 3–4), signaling strong co-benefits from weatherization and high-efficiency electrification for cost relief and health.
- Renter-heavy housing markets. High renter shares (e.g., 62.7% in Kodiak–Channel; 52.6% in East Kodiak) mean CPRP measures should include landlord/owner incentives and tenant protections to ensure access and prevent displacement.
- Language access needs. Limited English Proficiency is notably high in parts of the community (e.g., 17.08%; 100th percentile), requiring multilingual outreach, trusted messengers, and simplified enrollment.
- Health co-benefits targeting. Elevated chronic conditions in some areas (e.g., West Kodiak high blood pressure 30.6%, diabetes 9.7) and very high poor mental health in Kodiak Station (13.8%; 95th percentile) point to prioritizing indoor air quality, efficient heating, and healthy homes upgrades.
- Environmental and disaster risk readiness. Anticipated extreme-weather change is high (East 72.16; West 82.95; Kodiak Station 85.23) with elevated disaster-loss percentiles, supporting resilience-focused upgrades and backup power for critical facilities and housing.
- Industrial and hazard adjacency. Kodiak–Channel shows very high proximity to Risk Management Plan (RMP) facilities (81.36% of tract; 98th percentile) and higher hazardous-site proximity; West Kodiak also ranks high on RMP proximity—underscoring siting, air-quality, and emergency-preparedness co-benefits.
- Coverage and connectivity gaps. High uninsured rates in some tracts (e.g., 25.2%; 96th percentile) and limited internet access (e.g., 28.5% lacking) may suppress program uptake—design should include no-cost enrollment assistance and offline pathways.

- Older housing stock. Large shares of pre-1980s homes (e.g., West 66.45; 90th percentile; Kodiak-Channel 78.92; 96th percentile) indicate high retrofit potential and the need for safe material handling during upgrades.
- Age-sensitive design. Areas with many older adults (e.g., Kodiak-Channel 30.14% age 65+) suggest prioritizing low-barrier, health-protective measures and in-home services.

Overall implications: Design CPRP measures to be equitable, renter-inclusive, multilingual, and health-forward, with strong emphasis on resilience (weatherization, efficient and reliable heat, backup power) and siting/air-quality considerations near industrial risks. Pair technical incentives with hands-on enrollment help to overcome uninsured and connectivity barriers, and sequence upgrades in older housing for maximum savings and safety. (Sources summarized above.)

### Bottom line

Kodiak Island Borough shows high variation across tracts, but common threads—notably energy cost pressure, renter prevalence, language access needs, significant environmental/disaster exposure, and pockets of poor health—all point toward CPRP solutions that double as household cost relief and resilience upgrades, delivered through accessible, community-based implementation that meets renters, seniors, and LEP households where they are while accounting for industrial adjacency and older housing stock.

### Mitigation Strategies

#### Weatherization + clean heat in homes (oil-to-heat-pump where feasible)

Upgrading shell efficiency (air sealing, insulation, high-performance windows/doors) and pairing it with heat pumps where the electric supply is low-carbon can cut household fuel use and bills, while improving indoor air quality and moisture control—key for respiratory health and mold mitigation in older housing. The state documents large, proven savings and CO<sub>2</sub> reductions from Alaska’s Weatherization Assistance and rebate programs (typical 21–34% energy savings; ~30% CO<sub>2</sub> reduction), with strong track records serving low-income households and rural communities. These programs are explicitly designed to lower energy burden—directly responsive to Kodiak’s high heating costs and the share of cost-burdened renters.

#### Public buildings: retro-commissioning, deep efficiency, and beneficial electrification

Schools, health facilities, and municipal buildings are critical social infrastructure and major fuel users in small Alaska communities. State analysis highlights these assets as “early, doable” opportunities that free up public dollars, improve air quality (by burning less oil), and harden community shelters used during storms and disruptions—an SDOH-relevant resilience benefit. Modeling of statewide public-building upgrades shows substantial potential CO<sub>2</sub>e reductions by 2030 and 2050, and the program design contemplates implementation by municipal/tribal governments and school districts—important for channeling benefits to at-risk populations that rely most on these services.

#### Transportation electrification focused on access: electric vehicle supply equipment (EVSE) where people live, work, and travel

Strategically placed Level 2 and DC fast chargers reduce range anxiety, cut exposure to traffic-related air pollution, and lower transportation energy costs—benefits that land first when chargers are sited in neighborhoods with lower car reliability, longer commutes for services, or poor air episodes. The state’s EVSE program framework aligns with NEVI, quantifies per-site annual CO<sub>2</sub> reductions, prioritizes equitable access, and ties buildout to workforce opportunities—useful for pairing local training with installation and operations jobs in the region. Electrification opportunities should be pursued as shipping limitations allow, prioritizing municipal fleets where procurement is more feasible. Feasibility will be key factor, considering limitations on barge transfers of EVs. Emphasis instead can be on hybrid vehicles, efficiency improvements in heavy equipment, and active mobility.

#### Capacity and workforce to scale delivery (pairing rebates, audits, and local hire)

Delivering upgrades at the pace needed requires energy auditors, installers, and facility managers who understand cold-climate buildings and island logistics. The plan outlines a statewide approach to expand



training, increase outreach in underserved areas, and coordinate with regional housing authorities that have proven effective in communities off the road system. Embedding local hire and training in every project improves incomes and builds long-term maintenance capacity—one of the most durable SDOH co-benefits.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes in Kodiak will come first through home energy upgrades—weatherization plus clean-heat transitions—because they directly reduce high fuel use and bills, improve indoor air and moisture control, and build resilience against freight or weather disruptions that delay fuel deliveries. Alaska’s programs show ~21–34% energy savings and ~30% CO<sub>2</sub> reductions per home, alongside documented cost relief, mold/IAQ improvements, and fewer fuel deliveries—benefits that disproportionately help households with higher energy burdens, renter-heavy areas, seniors, and older housing. These programs have historically served low-income and rural communities at scale and are expanding with rebates and additional assessments to reach thousands more.

A second wave of outcomes comes from community infrastructure and clean transportation. Public-facility efficiency projects free up scarce municipal dollars for essential services and reduce exposure to combustion-related pollution—important for neighborhoods with higher health burdens. In transportation, EV charging sited where people live, work, and travel is designed to lower transportation energy costs, cut local air pollution along busy corridors, and create job pathways through installation and operations; the state’s approach emphasizes equitable access, workforce training, and measurable per-port CO<sub>2</sub> reductions. Beyond charging, diesel-reduction and distribution-upgrade programs (e.g., DERA/VEEP) deliver sizable PM and NO<sub>x</sub> reductions with associated health and cost benefits for rural communities. Taken together—and backed by a statewide commitment to steer substantial benefits to communities with the greatest need—these measures translate emissions reduction into tangible cost, health, and resilience gains for households and neighborhoods across Kodiak.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

#### Weatherization + Clean Heat in Homes (oil-to-heat-pump where feasible)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                  | Community Benefits                                                                                                          |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Per-home CO <sub>2</sub> e ↓ ~30% with envelope + heat pump; largest slice of community emissions is residential heat. | Directly reduces emissions in high-burden neighborhoods; prioritizable via income/energy-burden screens.                    |
| Energy cost savings | High             | Typical home energy use ↓ ~21–34%; large fuel-oil displacement; stabilizes bills vs delivered fuels.                   | Biggest dollar relief for low-income, seniors, and renters if paired with owner/landlord incentives and tenant protections. |
| Health benefits     | High             | Better IAQ, moisture/mold control; reduced in-home combustion and fuel handling; warmer, safer homes.                  | Targets households with elevated chronic/respiratory burdens; aligns with healthy-homes upgrades.                           |
| Resilience          | High             | Tight shells hold heat during outages; less dependence on freighted fuels; potential to pair with backup power later.  | Improves safety for medically vulnerable residents; reduces hardship during storms or supply delays.                        |
| Disbenefits / risks | Low–Moderate     | Upfront cost; cold-climate design/installer quality is critical; split-incentive in rentals.                           | Mitigate via no-cost audits, contractor QA/QC, multilingual outreach, and renter-inclusive program design.                  |

**Public Buildings: Retro-commissioning, Deep Efficiency, Beneficial Electrification**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                | Community Benefits                                                                               |
|---------------------|------------------|------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | RCx savings ~10–20%; deep retrofits ~25–40%+; sector share smaller than homes but concentrated.      | Cuts combustion at schools/clinics used most by at-risk households.                              |
| Energy cost savings | High             | Utility/fuel spend drops materially; frees municipal/school budgets for services.                    | Dollars repurposed to programs serving at-risk communities.                                      |
| Health benefits     | High             | IAQ/thermal comfort improvements in classrooms, clinics, and shelters.                               | Benefits children, elders, and those relying on public facilities.                               |
| Resilience          | High             | Efficient envelopes/HVAC extend passive survivability; facilities can serve as clean, warm shelters. | Enhances community-wide safety during outages/extremes where at-risk residents are most exposed. |
| Disbenefits / risks | Low–Moderate     | Capital constraints; construction disruption; O&M capacity needs.                                    | Address via phased work, operator training, and set-aside funds for rural procurement/logistics. |

**Transportation Electrification Focused on Access (EVSE where people live, work, travel)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                               | Community Benefits                                                                                          |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Each ICE-to-EV switch avoids roughly ~3–5 tCO <sub>2</sub> e/yr given gasoline dominance; total depends on uptake.  | Site chargers in at-risk areas to unlock early benefits where fuel costs are a burden.                      |
| Energy cost savings | Moderate         | Lower per-mile fuel and maintenance costs for EV drivers; strongest where gas prices/ferry logistics elevate costs. | Helps cost-burdened drivers (commuters, service workers) if charging is affordable and close to home.       |
| Health benefits     | Moderate         | Reduced tailpipe PM/NO <sub>x</sub> along roads and near hubs; quieter streets.                                     | Improves air quality in neighborhoods adjacent to traffic corridors.                                        |
| Resilience          | Low–Moderate     | Foundations for future V2X and essential-services fleets; redundancy if liquid fuels disrupted.                     | Value grows as municipal/tribal and health fleets electrify—benefits communities via reliable services.     |
| Disbenefits / risks | Moderate         | Utilization uncertainty; uptime/maintenance in harsh climates; access barriers if payment/apps are complex.         | Mitigate with reliability standards, cash/low-barrier payments, multilingual support, and equitable siting. |

### Capacity & Workforce (audits, installer training, local hire, outreach)

| Outcome             | Potential Impact    | Quantitative / Qualitative Assessment                                                                     | Community Benefits                                                                               |
|---------------------|---------------------|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate (indirect) | Enables scale for all other measures; throughput and quality drive realized savings.                      | Ensures priority projects are actually delivered.                                                |
| Energy cost savings | Moderate (indirect) | Faster, higher-quality retrofits → persistent savings; local workforce reduces travel/mobilization costs. | Builds durable capacity for ongoing service in underserved areas.                                |
| Health benefits     | Moderate (indirect) | Proper installs avoid IAQ/comfort regressions; trusted messengers boost uptake of healthy-homes upgrades. | Culturally and linguistically competent delivery improves reach to LEP and vulnerable residents. |
| Resilience          | Moderate            | Local technicians speed recovery after storms and keep systems working year-round.                        | Reduces downtime in at-risk neighborhoods; supports critical-facility maintenance.               |
| Disbenefits / risks | Low                 | Training pipelines take time; risk of out-migration of trained workers without retention pathways.        | Mitigate with apprenticeships, prevailing wages, local-hire policies, and career ladders.        |



### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower monthly energy bills and reduced exposure to fuel-price spikes.
- Healthier homes and public spaces (less combustion, better ventilation, moisture control).
- Greater resilience during storms/outages (tighter buildings, reliable services, future-ready charging).
- Local jobs and skills development through apprenticeships and installer training.
- Easier access when programs include no-cost audits, simple enrollment, and multilingual support.
- Renter-inclusive pathways that prevent displacement while improving unit quality.
- Budget relief for schools/clinics, improving services relied upon by at-risk residents.

Potential disbenefits if not designed equitably:

- Upfront cost or paperwork barriers if incentives are complex or reimbursement-only.
- Split-incentive in rentals leading to uneven access or rent increases post-upgrade.
- Performance gaps in cold climates if systems are poorly sized, installed, or maintained.
- Construction disruptions in homes/facilities without adequate phasing or temporary accommodations.
- Charging inequities if EVSE is sited far from at-risk neighborhoods or uses app-only payment.
- Limited contractor capacity causing long wait times or higher prices.
- Technology or outage risks if new systems lack operator training or backup power plans.

### Path Forward

Kodiak Island Borough is unusually well-positioned to achieve meaningful, near-term emissions reductions because its largest sources—residential heating oil and on-road gasoline—map directly to proven solutions: weatherization with clean heat and strategic transportation electrification. With hydropower already keeping grid emissions comparatively low, every gallon of fuel oil avoided or mile shifted from gasoline to electricity delivers outsized sustainability value. The same investments also address day-to-day challenges residents feel most: high energy bills, drafty or moisture-prone homes, and exposure to extreme weather that can disrupt fuel deliveries.

Centering outcomes is not only equitable—it's pragmatic. Targeting upgrades to households with the highest energy burden and to public facilities most relied upon by vulnerable residents maximizes cost relief, health gains, and resilience per dollar. Renter-inclusive design, language access, and simple enrollment pathways convert intent into participation, while local workforce pipelines keep economic benefits in the community and ensure systems are installed and maintained to cold-climate standards.

Success will hinge on disciplined delivery: a shared governance table that sets clear targets, coordinates funding, and tracks progress; phased implementation that starts with quick, visible wins and scales into deeper retrofits; and rigorous quality assurance to lock in real savings. By pairing technical measures with practical supports—contractor QA/QC, owner-tenant pathways, and operator training—Kodiak can reduce risk, prevent displacement, and build lasting capacity.

If the Borough follows this path—homes first, public facilities next, and EV charging where it unlocks the most gasoline displacement—it can cut a significant share of community-wide GHGs within a few years while improving comfort, health, and economic stability. Regularly refreshing the inventory and community indicators will keep efforts aimed at the highest-impact opportunities, ensuring that benefits are measurable, durable, and reach the residents who need them most.



# Kusilvak Census Area

Population: 8,100

Census Tract: 2158000100

Communities: Alakanuk, Chevak, Emmonak, Hooper Bay, Kotlik, Marshall, Mountain Village, Nunam Iqua, Pilot Station, Pitkas Point, Russian Mission, Saint Mary's, Scammon Bay



The Kusilvak Census Area faces a unique intersection of social, economic, and environmental challenges that shape both the causes of and potential solutions to air pollution. With some of the highest poverty and unemployment rates in the nation, limited healthcare and digital access, and a young, rapidly growing population, Kusilvak exemplifies the need for emissions reduction strategies that address community well-being alongside emission reductions. At the same time, the region's emissions profile reveals a heavy dependence on residual fuel oil and diesel for heating and power generation, as well as a transportation system dominated by trucks and freight vehicles. These realities underscore the importance of strategies that are both technically effective and socially equitable.

For vulnerable communities, which make up the majority of Kusilvak's population, the benefits and risks of mitigation efforts are especially significant. Well-designed strategies can reduce household energy burdens, improve indoor and outdoor air quality, and strengthen resilience to extreme weather, while also creating pathways for local employment and long-term economic stability. Conversely, without careful attention to equity, high upfront costs, adoption barriers, and technology challenges could leave at-risk households behind. This analysis explores the potential benefits and disbenefits of key mitigation strategies across buildings, electricity generation, and transportation, with explicit attention to how these interventions could impact the daily lives and long-term prospects of Kusilvak residents.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Weatherizing homes and switching heating away from heavy fuel oil.
2. Diversifying electricity through wind, solar, and storage to reduce petroleum-based generation.
3. Improving transportation efficiency with cleaner freight options and small-scale EV pilots.

These strategies directly address the region's largest emissions sources while aligning with the realities of poverty, high fuel costs, and limited infrastructure.

## Emissions Data Overview

Total Modeled Emissions: 43,914 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (76.59 %)

- Residential Sector (48.30%)
  - Dominated by Residual Fuel Oil No. 5, accounting for 18,412.89 mt CO<sub>2</sub>e (41.93% of total emissions).
  - Electricity: 2,605.51 mt CO<sub>2</sub>e (5.93%).
  - Wood/Wood Residuals: 114.76 CO<sub>2</sub>e (0.26%).
- Commercial Sector (28.47%)
  - Distillate Fuel Oil No. 1: 7,637.00 mt CO<sub>2</sub>e (17.39%)
  - Propane: 583 mt CO<sub>2</sub>e (1.33%).
  - Electricity: 4,261.14 mt CO<sub>2</sub>e (9.7%).
  - Wood/Wood Residuals: 21.20 CO<sub>2</sub>e (0.05%).
- Industrial Sector: 0%. No direct emissions from industrial combustion processes were reported.

### Transportation (23.41%)

By Fuel Type

- Motor Gasoline: 8,470.83 mt CO<sub>2</sub>e (19.29 %)
- Diesel Fuel: 1,807.30 mt CO<sub>2</sub>e (4.12 %)

By Vehicle Type

- Trucks (including commercial / heavy vehicles): 9,600.77 mt CO<sub>2</sub>e (~93.41 % of transport emissions)
- Passenger vehicles: 663.90 mt CO<sub>2</sub>e (6.46 %)
- Motorcycles / smaller modes: 13.46 mt CO<sub>2</sub>e (0.13 %)

### Electricity Generation

- Total electricity consumption: 25,915.80 MWh
- Fuel mix for generation:
  - Wind: 2,073.26 MWh → 0.00 mt CO<sub>2</sub>e
  - Petroleum (diesel, oil-based generation): 23,842.54 MWh → 6,866.65 mt CO<sub>2</sub>e

Electricity is heavily dependent on petroleum-based generation. Wind is part of the mix but contributes a small share, indicating limited renewable integration.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- Stationary combustion dominates emissions (~ 76.6 %), with the residential sector the largest contributor (~ 48 %).
- Residual Fuel Oil No. 5 is the single largest fuel source, underscoring dependence on high-carbon heating fuels.
- Transportation contributes nearly a quarter of emissions, with heavy vehicle use and gasoline as the leading factors.
- Electricity generation adds ~ 13.5 % of emissions, almost entirely from petroleum combustion.



## Social Determinants of Health

### Environmental Conditions

- Extreme Weather Change (9.09 index score): While relatively low compared to high-risk regions, changing weather patterns are already measurable.
- Annualized Disaster Loss (\$376,584.59; 21st percentile): Below average compared to the nation, but damages still represent significant local vulnerability given the small population base.
- Diesel PM & Air Toxics (0.00): Minimal reported air pollution exposure, suggesting clean air quality.
- Hazardous Sites Proximity (34.66 percentile): Slight exposure to hazardous sites, though relatively low compared to national averages.
- Pre-1980s Housing (43.18 percentile): Nearly 35% of occupied housing stock predates 1980, increasing risks from aging infrastructure, energy inefficiency, and possible contaminants.
- Airport Proximity (9.66 percentile): Small but notable exposure due to reliance on regional air travel.

**Implications:** The Kusilvak region is relatively insulated from many industrial pollution sources but vulnerable to aging housing and infrastructure. Limited disaster losses suggest resilience, yet changing weather patterns may disproportionately impact small, resource-limited communities.

### Public Health Indicators

- Chronic Disease Prevalence (Asthma, Cancer, Diabetes, Heart Disease all at 0.00): Reported prevalence is listed as zero, likely a data reporting gap rather than true absence.
- Mental Health (0.00 prevalence reported): Again, data is likely incomplete; underreporting could mask existing burdens.
- Life Expectancy (0.00 reported): Absence of reported values indicates missing or suppressed data.

**Implications:** Lack of data impedes understanding of health vulnerabilities. Given socioeconomic context (high poverty, limited healthcare access), underlying health burdens are likely undercounted, leaving residents at risk in adapting to environmental stressors.

### Socioeconomic Factors

- Poverty (<200% Federal Poverty Level (FPL): 69.56%; 99.43 percentile): Extremely high poverty rate—nearly 7 in 10 residents live in or near poverty.
- Education (No HS diploma: 21.40%; 98.30 percentile): Very high rates of limited educational attainment.
- Unemployment (12.40%; 96.02 percentile): Nearly double the national average, placing Kusilvak among the highest nationally.
- Uninsured (18%; 77.84 percentile): Health coverage gaps create vulnerability.
- Internet Access (33.90%; 93.18 percentile): One-third of residents lack internet, limiting access to information, services, and remote work opportunities.
- Housing Burden (16.97%; 14.20 percentile): Housing costs appear relatively low compared to income levels, though median home value data is suppressed (\$0.00).
- GINI Inequality Index (0.43; 70.45 percentile): Income inequality is moderate to high compared nationally.
- Demographics (40.5% under 18; 99.43 percentile): Youth-dominated population with fewer older adults (5.82%).
- Disability (12.9%; 53.98 percentile): Consistent with national averages, indicating additional care and accessibility needs.

**Implications:** The Kusilvak area faces severe economic hardship, limited educational attainment, and high unemployment. These conditions increase dependency on external assistance and constrain local capacity to adopt costly or complex sustainability measures. The large youth population indicates long-term stakes in education, opportunity, and resilience planning.



### Transportation Insecurity

- Access Score (0.27; 65.48 percentile): Indicates limited and inequitable access to reliable transportation.
- Traffic Fatalities (5.27 per 100,000; 82.95 percentile): Higher-than-average traffic-related mortality, reflecting safety challenges in a remote region with limited infrastructure.
- Cost Burden (0.00): Data not captured or not applicable, likely reflecting unique rural conditions.

**Implications:** Restricted transportation access and safety challenges limit mobility and connectivity. This shapes the community's ability to engage with healthcare, education, and employment opportunities, and will affect how emissions reduction strategies—such as reducing fuel reliance—are experienced locally.

### Intersection with Emissions Reduction Planning

The Kusilvak Census Area's social determinants of health reveal a fragile socioeconomic foundation with high poverty, unemployment, and limited healthcare and digital access. Environmental exposures are currently modest, but aging housing stock and extreme weather variability could elevate risks quickly.

- High poverty and low educational attainment may limit adoption of new technologies or infrastructure tied to pollution reduction unless supported by external funding.
- Limited transportation and connectivity amplify logistical barriers to program participation, requiring localized and culturally relevant strategies.
- A disproportionately young population means long-term health and environmental policies will have multi-generational impacts.

**Overall Implication:** For Kusilvak, emissions reduction strategies must be designed with equity and accessibility at the forefront. Without addressing the entrenched socioeconomic vulnerabilities, implementation risks reinforcing disparities rather than advancing resilience.





## Mitigation Strategies

### Building Energy & Heating Transition

Because residential stationary combustion makes up the largest share of local emissions, the most significant opportunities lie in transforming how homes and buildings are heated. Much of the housing stock relies on heavy heating oils like Residual Fuel Oil No. 5, a particularly carbon-intensive fuel. Coupled with the fact that many homes are older and energy-inefficient, this creates both environmental and economic burdens. By shifting toward cleaner heating options—whether through electrification, renewable-powered district systems, or expanded weatherization—residents could see lower fuel costs, improved indoor air quality, and reduced reliance on imported fuels. These changes would not only cut emissions but also directly ease the energy cost burdens faced by households already struggling with high poverty rates.

### Electricity Generation Diversification

Electricity in Kusilvak is still heavily dependent on petroleum-based generation, which contributes significantly to the community's emissions. While some wind energy is already in use, it makes up only a fraction of the overall supply. Expanding renewable generation through additional wind, solar, and storage systems could substantially reduce emissions while improving resilience to fuel price volatility and supply disruptions. Microgrid development could strengthen community self-reliance and support essential services such as schools and health facilities. Diversifying electricity sources would also improve energy security and create opportunities for more stable long-term costs for low-income households.

### Transportation Efficiency & Alternative Mobility

Transportation is the second-largest contributor to emissions, with heavy trucks and freight vehicles accounting for most of the total. This reflects both the geographic realities of moving goods across long distances and the community's dependence on a limited set of transportation options. Strategies to improve efficiency—such as modernizing freight vehicles, piloting electric or hybrid alternatives, and strengthening local transit solutions—would not only lower emissions but also enhance safety and access. Given the high rate of traffic fatalities, transportation investments could yield dual benefits by improving health and mobility while reducing fuel dependency.

### Improved Outcomes for Overburdened and Underserved Communities

Implementing building, electricity, and transportation strategies in Kusilvak would bring significant benefits for vulnerable communities. Transitioning away from heavy fuel oil and investing in weatherization would directly lower household energy costs, which currently consume a disproportionate share of limited incomes. Warmer, more efficient homes would also improve health outcomes by reducing exposure to drafts, mold, and indoor air pollutants, particularly important in a region with high poverty and incomplete healthcare access. At the same time, replacing diesel-based electricity with renewable generation would reduce exposure to generator emissions, stabilize long-term energy prices, and improve service reliability for critical facilities such as schools and clinics.

Transportation improvements would also enhance equity by expanding mobility options for households with limited access to vehicles and reducing dependence on expensive imported fuels. By lowering both the financial and environmental burdens of energy and transportation, these strategies would ease persistent cost-of-living pressures and create more stable, healthier living conditions. Taken together, the transition supports not just emissions reduction but also tangible improvements in day-to-day life for Kusilvak's at-risk residents, aligning sustainability actions with immediate community well-being.

**Benefit (Disbenefit) Quantification or Qualitative Analysis****Building Energy & Heating Transition**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                             | Community Benefits                                                                                                              |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Residential + commercial heating are the largest sources; Residual Fuel Oil No. 5 $\approx$ 18.4k mt, plus distillate/propane. If weatherization + fuel-switching reach a meaningful share of homes, a $\sim$ 20–40% cut of residential stationary emissions is plausible ( $\sim$ 4.2k–8.5k mt). | Direct emissions reductions in homes where at-risk residents live; benefits flow immediately to the most vulnerable households. |
| Energy cost savings | High             | Weatherization cuts heating fuel use; switching from heavy oil to efficient electric heat lowers consumption and reduces price volatility. Savings vary, but double-digit % bill reductions are common after retrofits.                                                                           | Relieves high energy burdens for at-risk households; frees income for food, healthcare, and essentials.                         |
| Health benefits     | High             | Improved building envelopes and cleaner heat reduce indoor pollutants, drafts, and moisture/mold, improving respiratory outcomes.                                                                                                                                                                 | At-risk residents—often in older, less efficient homes—gain the most from healthier indoor environments.                        |
| Resilience          | High             | Tighter homes + reliable heat systems improve protection during cold snaps and fuel shortages.                                                                                                                                                                                                    | Enhances safety for those with the least resources to respond to disruptions.                                                   |
| Disbenefits / risks | Moderate         | Up-front costs, contractor capacity, and cold-climate technology challenges. Some homes may need electrical upgrades.                                                                                                                                                                             | Without targeted support, upgrades could bypass at-risk households; equitable program design is essential.                      |



**Electricity Generation Diversification (Wind / Solar + Storage, Hybridizing Diesel)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                      | Community Benefits                                                                                                                            |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Petroleum-based generation ≈ 6.9k mt. Displacing a portion with wind/solar + storage could cut ~30–60% of those emissions (~2.1k–4.1k mt). | Cleaner power reduces community exposure to emissions and stabilizes energy access for households and services critical to at-risk residents. |
| Energy cost savings | High (long-term) | Diesel displacement lowers fuel costs and shields against volatility. After capital investment, renewable power can be cheaper.            | Stabilizes utility rates for low-income households, which are most sensitive to fuel price spikes.                                            |
| Health benefits     | Moderate         | Less generator exhaust and noise; indirect health improvements via lower heating/electricity costs.                                        | Benefits flow community-wide, but disproportionately matter for at-risk households with higher exposure to local generator emissions.         |
| Resilience          | High             | Microgrids and storage reduce vulnerability to shipping delays and outages.                                                                | Keeps clinics, schools, and water systems online—services especially important for at-risk communities.                                       |
| Disbenefits / risks | Moderate         | High up-front costs; maintenance and intermittency challenges; risk of delayed implementation.                                             | If costs are passed onto ratepayers, at-risk households could be disproportionately affected; equitable funding design is crucial.            |

**Transportation Efficiency & Alternative Mobility (Freight Efficiency, Targeted EV / Fleet Pilots, Community Shuttles)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                 | Community Benefits                                                                                                                     |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Transportation ≈ 10.3k mt, mostly from trucks. Efficiency gains and limited EV adoption could yield ~10–25% reductions (~1.0k–2.6k mt).                               | Freight efficiency lowers the delivered cost of goods, and public fleet upgrades directly benefit services used by at-risk households. |
| Energy cost savings | Moderate         | Lower freight fuel use reduces embedded shipping costs. EVs reduce operating costs for fleets. Community shuttles spread savings by reducing per-capita travel costs. | At-risk households without reliable vehicles gain improved access and reduced travel expenses.                                         |
| Health benefits     | Moderate         | Fewer tailpipe emissions and potential safety gains from organized shuttles and newer vehicles.                                                                       | Improves air quality and traffic safety in villages, benefitting children and elders in at-risk populations.                           |
| Resilience          | Moderate         | Reduced fuel dependency and greater reliability in critical service fleets.                                                                                           | Improves access during supply disruptions; offers mobility for households without private vehicles.                                    |
| Disbenefits / risks | Low–Moderate     | Cold-weather challenges for EVs, limited infrastructure, risk of stranded assets.                                                                                     | If infrastructure is clustered in better-off areas, at-risk households may be excluded; planning must prioritize equity.               |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy costs through weatherization, cleaner heat, and more stable power prices.
- Improved indoor and outdoor air quality, reducing respiratory risks in homes and communities.
- Greater energy security and resilience with reliable heating, microgrids, and reduced dependence on imported fuels.
- Enhanced access to essential services like schools, clinics, and transportation for residents without private vehicles.
- Local workforce opportunities in construction, renewable energy, and maintenance, providing jobs in communities with high unemployment.

Potential disbenefits if not designed equitably:

- High upfront capital costs for clean energy projects could raise rates or housing costs if not subsidized.
- Risk of uneven adoption, where better-off households benefit first unless programs are explicitly designed for risk management.
- Technology performance challenges in Arctic conditions (heat pumps, EVs, storage systems) may reduce effectiveness.
- Logistical and maintenance hurdles for remote communities, requiring sustained support and training.
- Program complexity could limit participation if digital access, education, or outreach barriers are not addressed.

### Path Forward

The analysis of social determinants of health and emissions in the Kusilvak Census Area highlights both the urgency and opportunity of aligning emissions reduction strategies with community well-being. The region's dependence on residual fuel oil and diesel, coupled with high poverty and unemployment rates, places a heavy burden on households and limits flexibility to absorb new costs or risks. At the same time, these conditions create strong justification for strategies that can deliver multiple benefits—lowering emissions while improving affordability, health, and resilience.

Looking ahead, three categories of strategies emerge as the most impactful: improving building efficiency and heating systems, diversifying electricity generation through renewables and storage, and enhancing transportation efficiency and mobility options. Buildings represent the greatest near-term opportunity, given their outsized role in emissions and household energy burdens. Electricity diversification offers system-level benefits that improve long-term reliability and cost stability, while transportation strategies, though smaller in scale, can meaningfully improve access, safety, and affordability.



The path forward for Kusilvak requires pairing technical solutions with equity-centered design. Programs must prioritize at-risk community participation through subsidies, no-cost weatherization, targeted workforce training, and inclusive community engagement. Regional and state partnerships will be essential to secure funding, overcome logistical barriers, and scale renewable infrastructure suited to Arctic conditions. By embedding equity into every step, Kusilvak can pursue emissions reduction in ways that not only lower emissions but also build healthier homes, more resilient infrastructure, and stronger economic foundations for future generations.



# Lake and Peninsula Borough

Population: 1,312

Census Tract: 2164000100

Communities: Chignik, Chignik Lagoon, Chignik Late, Egegik, Igiugig, Iliamna, Ivanof Bay, Kokhanok, Levelock, Newhalen, Nondalton, Pedro Bay, Perryville, Pilot Point, Pope-Vannoy Landing, Port Alsworth, Port Heiden, Ugashik

Kokhanok: © kokhanok.com

Lake & Peninsula Borough faces a unique intersection of challenges: some of the highest household energy burdens in the nation, dependence on costly imported fuels, limited healthcare access, and economic conditions that place many residents well below the federal poverty line. At the same time, the borough's emissions profile is dominated by a few concentrated sources—petroleum-based electricity generation, heating with fuel oil, and gasoline and diesel use in transportation. These conditions create both vulnerability and opportunity: while residents carry disproportionate costs and health risks, targeted strategies have the potential to deliver outsized benefits when aligned with local needs.

The framework for action must be guided by principles of equity and resilience. Community strategies are central to this approach, ensuring that solutions prioritize vulnerable and remote households and institutions. By focusing on measures that lower costs, cut emissions, and strengthen local capacity, the borough can achieve multiple benefits: improved public health, reduced dependence on volatile fuel shipments, economic opportunity through workforce development, and more reliable services for schools and clinics.

The following analysis identifies three priority strategies with the greatest potential to reduce emissions while advancing equitable outcomes. Together, they represent a roadmap for how emissions reduction can also serve as a tool for strengthening community wellbeing, resilience, and self-reliance in one of Alaska's most remote regions.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Deep Energy Efficiency and Housing Weatherization
2. Renewable Microgrids and Distributed Clean Power
3. Targeted Transportation Transition

Together, these strategies directly address the borough's largest emission sources (buildings, electricity, and transport) while tackling the core inequities—energy poverty, poor health, and economic fragility—that shape daily life in at-risk communities. They are impactful because they:

- Cut emissions where they are most concentrated (heating oil, diesel, gasoline).
- Deliver measurable cost savings for households already under extreme energy and transportation burdens.
- Improve health and resilience, particularly for low-income, uninsured, and remote residents.
- Create local capacity and jobs, building long-term sustainability.

## Emissions Data Overview

Total Modeled Emissions: 32,057 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (21.26%)

- Residential Sector (15.31%)
  - Electricity: 593 mt CO<sub>2</sub>e (~1.85 %)
  - Natural Gas: 23.11 mt CO<sub>2</sub>e (~0.07 %)
  - Residual Fuel Oil No. 5: 4,289.74 mt CO<sub>2</sub>e (~13.38 %)
  - Wood and wood residuals: 3.21 mt CO<sub>2</sub>e (~0.01 %)
- Commercial Sector (5.94%)
  - Distillate Fuel Oil No. 1 (commercial): 1,074.56 mt CO<sub>2</sub>e (3.35 %)
  - Propane (commercial): 82.03 mt CO<sub>2</sub>e (0.26 %)
  - Electricity (commercial): 746.02 mt CO<sub>2</sub>e (2.33 %)
  - Wood and wood residuals (commercial): 2.98 mt CO<sub>2</sub>e (~0.01 %)
- Industrial Sector: 0%. No direct emissions from industrial combustion processes were reported.

### Transportation (78.74%)

By fuel type

- Diesel fuel: 4,203.31 mt CO<sub>2</sub>e (13.11 %)
- Motor gasoline: 21,038.92 mt CO<sub>2</sub>e (65.63 %)
- Electricity: 0.16 mt CO<sub>2</sub>e (~0 %)

By vehicle type

- Trucks: 22,570.32 mt CO<sub>2</sub>e (~89.41 %)
- Passenger vehicles: 2,638.39 mt CO<sub>2</sub>e (~10.45 %)
- Motorcycles: 33.68 mt CO<sub>2</sub>e (~0.13 %)

### Electricity Generation

- Electricity consumption: 6,549.21 MWh
- Generation sources:
  - Petroleum: 4,649.94 MWh → 1,339.18 mt CO<sub>2</sub>e (100 % of generation emissions)
  - Hydro: 1,833.78 MWh → 0 mt CO<sub>2</sub>e
  - Wind: 65.49 MWh → 0 mt CO<sub>2</sub>e

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- Transportation dominates emissions (~79 %), driven mostly by gasoline use in trucks. However, the modeled inventory only includes on-road vehicles and electricity use; it does not capture emissions from the region's air taxi fleet that provides critical year-round access between many communities. As a result, actual transportation-related emissions are likely higher than reported, and aviation fuel use should be considered qualitatively when prioritizing mitigation strategies.

- Residual fuel oil for heating is a significant source in stationary combustion.
- Petroleum-based electricity generation contributes nontrivially.
- Renewable electricity sources (hydro, wind) are present but currently offset none of the emissions.

## Social Determinants of Health

### Environmental Conditions

- Extreme Weather Risk: Anticipated changes in extreme weather are moderate (18.18), suggesting the region is vulnerable but not in the highest national percentile.
- Disaster Losses: Annualized disaster losses are relatively low in dollar terms (\$285,107.66) and at the 16th percentile nationally, but still represent meaningful community risk given the small population base.
- Air Quality: Diesel particulate matter exposure is minimal (0.00), while toxic releases to air (3rd percentile nationally) remain very low. Cancer risk from air toxics is modest (8.00).
- Hazardous Sites: Proximity to hazardous or Superfund sites is almost negligible, though there are formerly used defense sites that may pose lingering environmental concerns.
- Housing Stock: About 32% of homes were built before 1980, placing them at the 36th national percentile. This indicates moderate potential for older housing-related risks (asbestos, lead paint, poor insulation).

Implications: Environmental risks are moderate and mostly tied to legacy defense sites and older housing stock, not ongoing industrial pollution. This suggests that while acute environmental exposures are limited, environment-driven changes (storms, permafrost thaw, extreme weather) could magnify existing vulnerabilities and infrastructure stress.

### Public Health Indicators

- Chronic Disease: Asthma (2.07%), cancer (0.88%), high blood pressure (6.05%), and diabetes (2.14%) are all relatively low in raw percentages but sit within lower percentiles nationally. Heart disease, however, stands out at the 76th percentile.
- Mental Health: Poor mental health prevalence (2.84%) is modest, though access to services may be constrained.
- Life Expectancy: Average life expectancy is 77 years, but low life expectancy is at the 64th percentile nationally, suggesting disparities exist within the region.

Implications: The overall health burden is not dominated by high rates of chronic disease but is marked by significant cardiovascular concerns and uneven life expectancy. Limited healthcare access likely amplifies these risks, underscoring the importance of prevention and community-level health supports.

### Socioeconomic Factors

- Poverty & Inequality: Nearly 40% of residents live under 200% of the federal poverty line, placing the borough in the 86th percentile nationally. The GINI index of 0.40 reflects moderate income inequality.
- Education: 11.8% of adults lack a high school diploma, which is very high (87th percentile nationally).
- Employment: Unemployment is 12.9%, one of the highest rates in the country (97th percentile).
- Housing & Insurance: A significant share of households rent (35.5%), but housing cost burden is low (13.39%). However, the median home value is just \$114,900 (22nd percentile nationally). Notably, nearly 26% of residents are uninsured—the 97th percentile nationally.
- Digital Divide: 31.4% of households lack internet access (91st percentile), severely limiting educational, economic, and telehealth opportunities.
- Energy Burden: Households spend about 10% of income on energy, ranking at the 99th percentile nationally—an extreme hardship.
- Demographics: The community is relatively young (25.6% under 17), with 10.6% over 65 and 16% reporting disabilities. Limited English proficiency is low (1%).

**Implications:** Socioeconomic conditions are highly challenging, with poverty, unemployment, lack of insurance, and high energy burdens all contributing to health inequities. These factors indicate that emissions reduction programs must be designed with affordability, access, and workforce development in mind to avoid deepening existing disparities.

### Transportation Insecurity

- **Access:** The transportation access score is very low (0.06, near the 47th percentile).
- **Cost Burden:** Transportation costs consume about 19% of household resources, placing the borough in the 90th percentile nationally.
- **Safety:** Traffic fatality rates are 2.01 per 100,000 people, aligning with the national midpoint (58th percentile).

**Implications:** Transportation access is limited and costly, compounding economic challenges. High dependence on costly fuel and long travel distances intensify barriers to healthcare, education, and economic opportunity. Emissions reduction strategies that increase costs of transport fuels could disproportionately impact residents unless alternatives are provided.

### Intersection with Emissions Reduction Planning

The social determinants in Lake and Peninsula Borough highlight several considerations:

- **High Energy Burden and Cost Sensitivity:** With residents already spending disproportionately on energy and transportation, emissions reduction measures that raise costs could worsen hardship unless offset with subsidies, efficiency upgrades, or localized renewable solutions.
- **Economic Fragility:** High unemployment and poverty levels mean that emissions reduction programs should prioritize job creation, training, and income stability for residents.
- **Health Vulnerability:** Cardiovascular disease prevalence and uneven life expectancy suggest that any increase in environmental stressors (heat, smoke, poor air quality) may disproportionately affect residents.
- **Access Barriers:** Limited internet access and transportation challenges mean outreach, education, and program delivery will require tailored, community-specific approaches.
- **Youthful Population:** With more than a quarter of residents under 17, investments in schools and youth engagement could provide long-term resilience and intergenerational benefits.

## Mitigation Strategies

### Energy Resilience and Affordability

High household energy burdens (among the worst in the nation) and reliance on petroleum for both electricity and heat underscore the need to lower costs while cutting emissions. Transitioning to renewable and distributed generation—particularly through hydro, wind, and solar where feasible—would directly reduce dependence on expensive imported fuels. Pairing this with deep energy efficiency retrofits in older housing stock could cut both household expenses and emissions. Weatherization, improved insulation, and electrification of heating systems would also reduce exposure to health risks associated with outdated housing. These measures not only stabilize costs but also build resilience against extreme weather events, which are projected to increase in the region.

### Transportation Transformation

Transportation is by far the largest emissions sector in the borough, with trucks and gasoline use dominating the modeled inventory. In practice, mobility also depends heavily on an air taxi fleet that connects roadless communities; while aviation fuels are not captured in the current inventory, they represent an additional and likely significant source of emissions. The lack of affordable alternatives across both ground and air travel makes transportation a financial and health stressor. Strategies here should focus on community-scale solutions such as improving the efficiency and reliability of existing vehicles, supporting shared trips for essential travel, and expanding access to more fuel-efficient boats.



and aircraft for remote communities. Where technically and economically feasible, communities may also choose to pilot small-scale use of alternative-fuel or electric vehicles and consider limited charging infrastructure to support critical services. Partnering with air carriers to improve operational efficiency, plan for future low-carbon aviation options (such as sustainable aviation fuels or hybrid-electric aircraft as they become viable), and electrify ground-support equipment can further reduce aviation-related emissions over time. At the same time, enhancing digital connectivity would reduce the need for long, costly trips by enabling telehealth, distance learning, and remote work. Reducing transport emissions across road, marine, and aviation modes would therefore also improve access to education, healthcare, and jobs, making this a cross-cutting investment in equity.

### Health and Housing

The region faces elevated risks of cardiovascular disease and uneven life expectancy, along with significant poverty, unemployment, and uninsured rates. Mitigation strategies that improve housing quality—through retrofits, electrification, and renewable heating—should be paired with programs that directly link to community health benefits. For example, replacing diesel generators with clean microgrids reduces air pollution and noise while providing reliable power for health clinics and schools. Creating local energy and housing jobs can also improve economic stability while addressing root causes of poor health outcomes. By prioritizing housing and health interventions together, the region can improve wellbeing while reducing emissions.

### Improved Outcomes for Overburdened and Underserved Communities

Expanding fair and strategic approaches in the borough has the potential to transform the balance between cost, reliability, and sustainability in energy and community development. At present, residents face some of the highest energy burdens in the country, with heavy dependence on imported petroleum for both electricity generation and heating. Deploying distributed renewables such as solar, small-scale wind, and battery storage at community facilities or clustered housing sites would reduce reliance on diesel, lower household energy costs, and provide cleaner, more resilient power. In turn, this stabilizes local budgets, freeing up household resources for food, health care, and education.

Improved outcomes also extend into public health and equity. By replacing diesel generators and residual fuel oil heating with clean local energy, these strategies directly reduce exposure to particulate matter and toxins that aggravate heart disease and respiratory conditions—both of which are concerns in the borough. Cleaner energy infrastructure can also support essential services such as schools and clinics with more reliable power, improving educational continuity and healthcare delivery. This reduces health disparities while building community resilience to environmental-driven disruptions like storms or supply interruptions.

Community models can also strengthen the economic and social fabric of the region. Building, maintaining, and operating distributed systems creates local employment pathways and technical skill development opportunities, addressing high unemployment and low educational attainment rates. Paired with targeted training, these strategies give residents the capacity to manage and sustain their own energy systems, reducing dependence on external contractors. Over time, this fosters self-reliance and builds intergenerational skills that can anchor young people in their communities. By aligning emissions reduction with local cost savings, health gains, and job creation, these approaches position Lake & Peninsula Borough to achieve not just emission reductions, but measurable improvements in quality of life.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Energy Resilience & Affordability**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                          | Community Benefits                                                                            |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Weatherization and electrification can cut around 20–30% of emissions per home; scaling across the borough could reduce thousands of tons of CO <sub>2</sub> e annually.       | High—vulnerable and remote households face the steepest energy burdens and benefit most.      |
| Energy cost savings | High             | Typical energy burden is ~10% of household income. Weatherization can save nearly 30% of annual bills, translating to large savings where heating fuel exceeds \$6 per gallon. | Strongly aligned with affordability for low-income and remote residents.                      |
| Health benefits     | Moderate–High    | Better indoor air quality, less exposure to mold, fewer particulates from oil/wood heating; important given high cardiovascular disease prevalence.                            | Health gains concentrated among vulnerable households most exposed to poor indoor conditions. |
| Resilience          | High             | Reduced dependence on bulk fuel shipments; distributed renewables and storage can keep schools and clinics operational during storms.                                          | Key for isolated communities with fragile supply chains.                                      |
| Disbenefits / risks | Low–Moderate     | High upfront costs, workforce shortages, and cold-climate performance challenges for some heat pumps.                                                                          | Without subsidies and local workforce, benefits may not reach the most vulnerable.            |

**Transportation Transformation**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Community Benefits                                                                                                                                                                                                    |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Transportation is one of the largest modeled emissions sources in the borough; improving vehicle and vessel efficiency, supporting shared trips, and selectively transitioning priority fleets to lower-carbon fuels or electric options can meaningfully reduce on-road and marine emissions. Aviation from the air-taxi fleet is not included in the current inventory, but operational efficiencies and emerging low-carbon aviation technologies could further cut total transport emissions over time | Focusing first on essential-service and community fleets (school, health, freight, and municipal vehicles or boats) helps ensure that cost and emissions reductions reach residents with the fewest mobility options. |
| Energy cost savings | Moderate–High    | More efficient vehicles, boats, and coordinated trip planning can lower fuel consumption, which is especially valuable where delivered gasoline and diesel costs are very high. In some communities, limited use of electric or hybrid vehicles for critical services may also reduce per-mile costs where electricity is reliably less expensive than fuel.                                                                                                                                               | Reduces cost of accessing healthcare, education, and goods in remote villages.                                                                                                                                        |

|                     |          |                                                                                                                                                                                                                                                            |                                                                            |
|---------------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Health benefits     | Moderate | Cleaner and more efficient ground and marine fleets can reduce diesel exhaust and other pollutants in village hubs, along docks, and near roads. Newer, safer equipment can also reduce accidents and spills                                               | Benefits most visible where households are near high-use corridors.        |
| Resilience          | Moderate | Diversifying transport options (shared vehicles, coordinated marine services) and, where feasible, pairing limited charging or improved fuel storage with local renewable power can reduce vulnerability to fuel supply interruptions and extreme weather. | Critical for essential medical, school, and community transport services.  |
| Disbenefits / risks | Moderate | High upfront costs for any fleet upgrades, uncertain performance of new technologies in extreme cold, sparse charging or maintenance infrastructure, and limited local capacity can all slow implementation or create reliability concerns.                | If only deployed in wealthier hubs, vulnerable areas could be left behind. |

### Health & Housing Equity

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                 | Community Benefits                                                                                 |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Retrofitting clinics, schools, and rental housing can achieve significant cumulative reductions in heating and facility emissions.                    | Targeting community facilities ensures broad reach to vulnerable groups.                           |
| Energy cost savings | High             | Schools and clinics are large fuel consumers; retrofits reduce costs and stabilize budgets for vital services.                                        | Protects services in communities with limited tax base and high poverty.                           |
| Health benefits     | High             | Warmer, drier, and cleaner indoor environments reduce respiratory and cardiovascular risks; stable power supports healthcare delivery and telehealth. | Focuses directly on uninsured and disabled populations disproportionately affected by poor health. |
| Resilience          | High             | Efficient and electrified buildings with backup storage keep essential services open during outages or supply disruptions.                            | Schools and clinics often double as shelters, maximizing impact.                                   |
| Disbenefits / risks | Low–Moderate     | Capital-intensive projects, logistical challenges in remote construction, and reliance on external contractors.                                       | Risks of “benefit leakage” if local workforce is not trained or included.                          |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy burden – reduced spending on heating fuel and electricity frees up income for essentials.
- Improved public health – cleaner indoor air, less particulate exposure, and more stable indoor environments.
- Local job creation – workforce development in construction, retrofits, and renewable system maintenance.
- Enhanced resilience – reduced dependence on fuel shipments and stronger backup power for clinics and schools.
- Community self-reliance – more local control over energy systems, lowering vulnerability to outside market shocks.
- Equity alignment – directs benefits to low-income, uninsured, and high-disability populations most affected by energy and health burdens.

Potential disbenefits if not designed equitably:

- High upfront costs – significant capital investment required for retrofits, renewables, and electrification.
- Workforce and capacity gaps – limited local contractors and skilled labor may slow implementation.
- Technology performance risks – cold climate impacts on some systems (e.g., heat pumps, EVs).
- Equity gaps if poorly designed – programs could bypass the most vulnerable if subsidies and outreach aren't prioritized.
- Logistical challenges – shipping materials, equipment, and maintaining systems in remote locations.

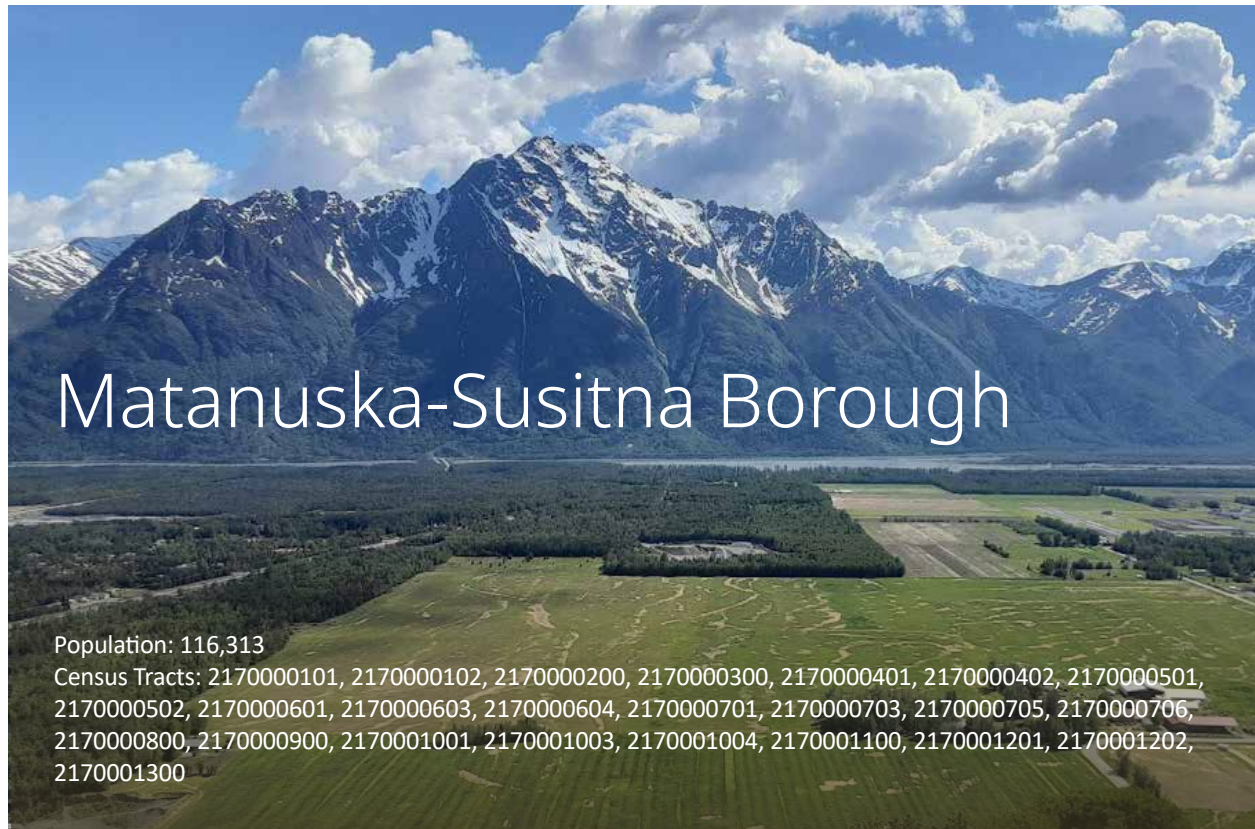
### Path Forward

Lake & Peninsula Borough is at a pivotal moment. The same conditions that make the region vulnerable—extreme energy costs, reliance on imported fuels, and health disparities—also highlight where the most impactful emissions reduction strategies lie. By focusing on deep energy efficiency and weatherization, renewable microgrids and distributed clean power, and targeted transportation transition, the borough can achieve significant emission reductions while also addressing the inequities that weigh most heavily on vulnerable households. These strategies deliver not only sustainability benefits but also lower household costs, improved health outcomes, and stronger resilience against disruptions.

The path forward should emphasize phased, community-centered implementation. Early action can begin with energy efficiency upgrades and weatherization in schools, clinics, and the most vulnerable homes, providing immediate cost and health relief. At the same time, planning and investment in renewable microgrids can reduce diesel dependence and ensure reliable power for essential services. Transportation efforts, starting with public fleets and community-shared vehicles, will lay the foundation for broader shifts in mobility. Each step must be paired with workforce development and local hiring to ensure that benefits remain within the community and build durable capacity.

Ultimately, success depends on aligning emissions reduction with community priorities. By grounding sustainability actions in the lived realities of at-risk households—those who spend the most on energy, face the steepest health risks, and have the least access to alternatives—the borough can create a roadmap that is both effective and just. This dual focus on sustainability and equity will allow Lake & Peninsula to not only reduce its emissions but also chart a future that is healthier, more resilient, and more self-reliant.





This regional roadmap summarizes current conditions in the Matanuska-Susitna Borough and identifies the most promising mitigation pathways that also improve outcomes. The work aligns with Alaska’s Comprehensive Sustainable Energy Action planning and is organized to move from conditions to place-types to priority strategies, without pre-judging program design or selecting specific projects. The immediate objective is to clearly describe what the region looks like today—socially, economically, and in terms of emissions—and to frame where mitigation can deliver the greatest combined sustainability and community benefits.

The assessment integrates tract-level social determinants of health (SDOH) with a multi-tract roll-up for each community, recognizing that conditions—and therefore benefits and barriers—vary widely across the Borough. Indicators such as energy burden, housing tenure and cost pressure, broadband and insurance gaps, chronic/behavioral health flags, disaster and flood exposure, and transportation access/safety were synthesized into neighborhood/subregion typologies. This place-based lens is paired with a high-level emissions inventory to show where pollution originates and where interventions can change day-to-day outcomes for households most at risk.

A few patterns shape the roadmap. Many tracts face high energy costs and housing cost burdens, with renter concentrations that introduce split-incentive challenges. Disaster and flood risks are spatially concentrated, while transportation safety risks and long travel distances raise both costs and exposure. Public and community facilities function as critical anchors—especially for at-risk residents—and become natural focal points for early, visible improvements. On the emissions side, community totals are driven primarily by stationary combustion in buildings (residential and commercial), with on-road transportation as the next largest source; the regional electricity mix is dominated by natural gas with a significant hydro share. Together, these conditions point to strategies that pair weatherization, public-facility efficiency, and cleaner grid power.

What follows applies that lens: a concise statement of SDOH conditions and typologies, an overview of emissions by category, sector, and fuel, and a set of strategy narratives tailored to local realities and at-risk priorities. Each strategy is accompanied by a benefit/disbenefit matrix—combining qualitative rankings with available quantitative ranges—to clarify likely emissions reductions, energy-cost savings, health and resilience gains, and potential risks that program design should mitigate.

### Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Weatherization + heat-pump conversions in homes (and small commercial)
2. Public facilities efficiency
3. Cleaner Railbelt power

Together these strategies directly target the largest emissions sources (buildings). All three also deliver outsized, near-term community benefits—lower bills, healthier indoor air, safer and more reliable access—especially for at-risk households.

### Emissions Data Overview

Total Modeled Emissions: 941,395 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

#### Stationary Combustion (61.82%)

- Residential Sector (34.32%)
  - Residual Fuel Oil No. 5: 54,248.74 mt CO<sub>2</sub>e (6.56% of community).
  - Natural gas: 203,544.45 mt CO<sub>2</sub>e (21.62%).
  - Propane: 2,881.56 mt CO<sub>2</sub>e (0.31%).
  - Electricity : 61,767.58 mt CO<sub>2</sub>e (6.56%).
  - Wood & wood residuals: 690.67 mt CO<sub>2</sub>e (0.07%).
- Commercial Sector (27.50%)
  - Distillate Fuel Oil No. 1: 82,261.56 mt CO<sub>2</sub>e (8.74%).
  - Natural gas: 126,977.39 mt CO<sub>2</sub>e (13.49%).
  - Propane: 6,279.79 mt CO<sub>2</sub>e (0.67%).
  - Electricity : 43,127.66 mt CO<sub>2</sub>e (4.58%).
  - Wood & wood residuals: 228.30 mt CO<sub>2</sub>e (0.02%).
- Industrial Sector: 0%

#### Transportation (28.16%)

By fuel type:

- Motor gasoline: 278,936.50 mt CO<sub>2</sub>e (29.63% of community).
- Diesel fuel: 80,447.29 mt CO<sub>2</sub>e (8.55%).
- Electricity: 3.23 mt CO<sub>2</sub>e (Negligible)

By vehicle type (within transport):

- Trucks: 297,968.53 mt CO<sub>2</sub>e (82.91% of transport emissions)
- Passenger vehicles: 60,907.95 mt CO<sub>2</sub>e (16.95%)
- Motorcycles: 510.55 mt CO<sub>2</sub>e (0.14%)

#### Electricity Generation (10.03%)

- Electricity consumption: 762,986.77 MWh
- Generation sources:
  - Hydro: 251,785.63 → 0 mt CO<sub>2</sub>e
  - Natural Gas: 511,201.14 → 104,898.47 mt CO<sub>2</sub>e (100%)

**Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%**

- Not included in this dataset.

**Key Takeaways**

- Total emissions: 941,395 mt CO<sub>2</sub>e (calendar year 2022).
- Category split: Stationary combustion 61.82%; Transportation 38.18% of community total.
- Stationary sectors: Residential 34.32%, Commercial 27.50%, Industrial 0% of community total.
- Top stationary fuels: Natural gas 203,544 mt; distillate fuel oil No. 1 82,262 mt; residual fuel oil No. 5 54,249 mt; electricity (residential 61,768 mt, commercial 43,128 mt).
- Transportation fuels (on-road): Motor gasoline 278,937 mt; diesel 80,447 mt; electricity ~3 mt.
- On-road vehicle mix: Trucks 82.91%, passenger vehicles 16.95%, motorcycles 0.14% of on-road transport emissions.
- Electricity generation (upstream mix for scope 1/2 profile): 762,987 MWh total; natural gas 511,201 MWh → 104,898 mt CO<sub>2</sub>e, hydro 251,786 MWh → 0 mt.

**Social Determinants of Health****Methodology**

This assessment aggregates tract-level indicators for multiple communities across the Matanuska-Susitna Borough to characterize one regional profile. Metrics are summarized as ranges (min–max) and typical conditions (qualitative “middle”/common values) across tracts, with notable outliers called out explicitly. Where variables are already reported as national percentiles, higher percentiles are interpreted as higher relative risk or burden. Population and housing context are used to interpret how conditions may concentrate (e.g., where renter share is high). The goal is to describe current conditions and distributional differences across the Borough rather than to select or evaluate interventions.

**Environmental Risk**

- Extreme weather & disaster loss: Anticipated changes in extreme weather range from ~18–88 (unitless index), with especially high values in Foothills (~88) and several Wasilla-area tracts (~54–81). Annualized disaster loss percentile is elevated across many tracts (mid-50s up to 97th percentile in Gateway), indicating outsized exposure to costly events.
- Flood risk: Share of local properties with flood risk spans ~1% to 23%, peaking in Butte/Lazy Mountain (23%); many tracts sit in the 6–15% band. These pockets imply uneven household and infrastructure exposure to flood damages.
- Industrial/hazardous proximity: Most tracts show little to no proximity to hazardous waste, RMP, and Superfund facilities (often 0th–30th percentiles), reducing direct toxics exposure concerns borough-wide. Exceptions include moderate Superfund proximity percentiles (teens–30s) in a subset of tracts.
- Air quality proxies: Diesel PM exposure is near zero to very low in most places; “air toxics cancer risk” percentiles cluster low–moderate, with higher values in the Palmer/Fairview vicinity.

What this means: Mat-Su’s environmental risks are dominated by weather- and water-related hazards rather than stationary industrial pollution. Disaster loss and flood risk are highly localized, so resilience and risk-reduction benefits will differ substantially by place.

**Health status**

- Chronic disease: Asthma prevalence ranges from ~1.6% to 10.1%, with the highest levels in Wasilla-Fishhook and elevated values in Palmer and several Wasilla tracts. Hypertension (~5.0%–30.9%) and diabetes (~1.3%–8.0%) are notably high in some Wasilla/Palmer-area tracts.
- Mental health: Estimated poor mental health prevalence ranges ~2.3% to 13.7%, with Foothills, Seldon, Wasilla-Fishhook, and Tanaina among the highest.

- Life expectancy: Average life expectancy varies ~74.3 to 86.0 years, indicating meaningful intra-borough differences in long-run health outcomes.

What this means: There are discrete clusters of elevated chronic and behavioral health burden, especially around parts of Wasilla/Palmer and select unincorporated communities. Health co-benefits (e.g., indoor air quality, wintertime comfort) will matter most where asthma and mental-health indicators are highest.

### Socioeconomic context

- Economic hardship: Residents under 200% Federal Poverty Level (FPL) range ~14% to 43%; Western Mat-Su and Willow are at the high end (>40%). Unemployment varies from ~3.3% to 11.2%, with several tracts in the 90th+ national percentile. Gini inequality indices are elevated (0.34–0.49) in multiple places.
- Insurance & internet: The uninsured rate ranges 8.6% to 33.1%, the latter in Western Mat-Su (~99th percentile nationally). Lack of internet access runs ~5% to 28%, with the highest in Willow (>86th percentile).
- Energy burden: Reported energy burden values are 3–9%, with national percentiles frequently in the mid-90s to 99th, especially in Matanuska River and Willow—signaling acute affordability pressures from energy costs in many communities.

What this means: Affordability and access barriers are widespread yet uneven: energy costs, patchy broadband, and high uninsured rates create structural obstacles to participating in programs and to realizing health and cost co-benefits from home upgrades.

### Housing & community fabric

- Tenure & cost pressure: Renter share ranges ~6% to 46% (notably high in North and South Wasilla), while housing cost burden spans ~19% to 45%, with South Wasilla among the highest (~95th percentile). Median home values vary significantly (~\$123k–\$320k).
- Stock & age: Mobile homes are a small but important share in some tracts (up to ~12% in Bogard). Pre-1960 housing is generally low but present in parts of Palmer and Butte/Lazy Mountain.
- Demographics: Seniors (65+) range ~7% to 23%, and youth (≤17) ~10% to 33%, producing communities with very different household needs (fixed incomes vs. large families). Disability rates reach ~21% in some tracts. Limited English proficiency is generally low but higher in North Wasilla.

What this means: Tenure mix and cost pressure signal split-incentive barriers in renter-heavy areas and affordability constraints for lower-income owners. Older/specialized stock (e.g., manufactured homes) and higher-disability or senior concentrations imply tailored accessibility and health-protective approaches.

### Transportation access, safety, and costs

- Access & costs: Transportation access scores often sit in the 70th–90th national percentiles, indicating limited access in many places; cost burdens frequently land in the 70th–90th percentiles as well.
- Safety: Traffic-fatality rates vary 0 to 30.6 per 100,000, with Western Mat-Su at the extreme high end (100th percentile), and multiple tracts in the 80th–95th percentile.

What this means: Long distances, winter conditions, and limited alternatives contribute to transportation insecurity and safety risks, which shape how residents can access programs, job sites, schools, and health services—and how feasible low-emission mobility choices will be.



## Neighborhood/Subregion Typologies

### A. Urban service hubs & renter pressure

*Example tracts: South Wasilla.*

**Signals:** Very high renter share and cost pressure alongside equity flags. South Wasilla shows renters ~46% (74th nat'l pct), cost-burden ~41% (92nd), uninsured ~20% (86th), and elevated energy burden (4%; 80th).

**Implications for CPRP:** Tenant-landlord split incentives and affordability headwinds will shape uptake. Enrollment supports should minimize upfront costs and be “renter-safe,” with offline access options to offset patchy broadband.

### B. Owner-dominant neighborhoods with high health burden

*Example tracts: Wasilla-Fishhook, Foothills, Seldon.*

**Signals:** High asthma/mental-health and cardio-metabolic indicators; tenure mixed but often owner-leaning. Wasilla-Fishhook: asthma 10.1% (96th), poor mental health 13.7% (94th). Foothills: asthma 9.5% (87th), poor mental health 13.5% (92nd). Seldon: asthma 9.6% (89th), poor mental health 13.5% (92nd).

**Implications for CPRP:** Health co-benefits (thermal stability, IAQ, moisture) will be salient motivators; outreach through clinics, schools, and employer channels can help reach households managing chronic conditions.

### C. Riverine / flood-exposed corridors

*Example tracts: Butte/Lazy Mountain, Matanuska River, Gateway.*

**Signals:** High flood-exposed properties and/or disaster-loss percentiles—Butte/Lazy Mountain flood risk 23% (88th) and disaster-loss 93rd; Matanuska River disaster-loss 81st; Gateway disaster-loss 97th with flood risk 12% (70th).

**Implications for CPRP:** Risk-aware sequencing and siting matter (avoid flood-prone investments, prioritize outage resilience and critical-load protection). Engagement should include hazard-mitigation partners.

### D. Outlying lakes/remote areas with high energy burden & access gaps

*Example tracts: West Lakes.*

**Signals:** High energy burden (7%; 97th), very high uninsured (~23%; 91st), and notable internet gaps (~15%).

**Implications for CPRP:** Emphasize affordability, mobile/low-friction enrollment, and local delivery; pair with basic access supports (paper applications, community navigators).

### E. Logistics/transport-adjacent “gateway” zones

*Example tracts: Greater Palmer, Gateway.*

**Signals:** High proximity to airports/major roads; in Greater Palmer RMP facility proximity is elevated (~19% of tract; 89th pct), with high-volume road and airport proximity also high. Gateway shows similar transport adjacency plus very high disaster-loss percentile.

**Implications for CPRP:** Noise/air exposure, freight activity, and reliability expectations are prominent; framing around reliability and community resilience will resonate.

### F. Young-family growth corridors with safety and cost frictions

*Example tracts: Knik Arm; overlapping corridors in Fishhook/Seldon.*

**Signals:** Knik Arm has high youth share (~31%; 86th), mobile-home presence (6%; 75th), and elevated traffic fatalities (~6.4 per 100k; 86th). Fishhook and Seldon also show high crash rates (~7.0–7.2 per 100k; ~88–89th) and high transportation cost burdens.

**Implications for CPRP:** Safety/reliability co-benefits and household budget relief are key narratives; delivery models should reduce long trips and winter exposure.

### Intersection with Emissions Reduction Planning

- Affordability first, especially for high-burden pockets. With energy burdens commonly at 95th–99th national percentiles and cost-stressed tracts (e.g., Western Mat-Su, Willow, Matanuska River), program design should anticipate upfront-cost barriers, credit constraints, and fuel-cost volatility. Co-benefits like thermal comfort and indoor air quality will be salient motivators in high-asthma, high-mental-distress communities.
- Tailor approaches by tenure and housing type. Renter-heavy areas (e.g., North & South Wasilla) face split incentives and may need owner participation and protections for tenants; manufactured homes and older stock will require fit-for-purpose upgrade pathways to realize emissions and health benefits.
- Pair resilience with mitigation where disaster and flood risks are elevated. Tracts with high disaster-loss percentiles (e.g., Gateway, Fishhook, Butte/Lazy Mountain) and higher flood-exposed properties need risk-aware sequencing—for example, ensuring upgrades reduce outage risks, protect critical loads, and avoid investments likely to be damaged by flooding.
- Address access barriers that blunt uptake. High uninsured rates (up to ~33%), limited broadband (up to ~28%), and transportation insecurity (70th–90th percentiles) mean programs should be reachable without reliable internet, be available locally or mobile, and reduce travel and paperwork friction. Outreach should reflect youth-heavy areas (schools as hubs) and senior-heavy areas (trusted local institutions, caregivers).
- Health-protective framing matters in hotspots. Where asthma, diabetes, hypertension, and poor mental health are elevated (e.g., Wasilla-Fishhook, Palmer, Foothills, Seldon, Tanaina), emphasize indoor air quality, moisture control, and thermal stability alongside emissions reductions—linking upgrades to health and productivity benefits residents already feel.
- Safety and mobility co-benefits should be recognized. In tracts with very high crash fatality rates (e.g., Western Mat-Su), any emissions-reducing mobility improvements should be framed with safety and access gains, including options that lessen long car trips or reduce exposure to dangerous corridors in winter conditions.
- Equity targeting and metrics. Given the wide spread in poverty, insurance coverage, and energy burden, equity screens should explicitly incorporate <200% Federal Poverty Level (FPL), uninsured, disability, renter share, and energy burden—and report outcomes by tract or community cluster to confirm benefits reach high-need pockets.

### Bottom line

Mat-Su's SDOH landscape is diverse and uneven: many tracts combine high energy costs, disaster/flood exposure, and transportation constraints with pockets of chronic disease and mental-health burden. Emissions reduction efforts that foreground affordability, access, resilience, and health co-benefits—and that are targeted to the specific mix of needs in each cluster of tracts—will be best aligned with on-the-ground conditions described here.



## Mitigation Strategies

### Targeted home weatherization for the highest-burden tracts

Weatherization directly reduces fuel use, indoor pollution, and monthly bills—key levers where energy burden and housing cost burden spike. South Wasilla shows very high housing cost burden (~41% of households; ~92nd percentile nationally) and elevated uninsured rates (~20%), with higher energy burden (~4%; ~80th percentile)—signals that efficiency and utility-bill relief will be most impactful if targeted there first. Wasilla-Fishhook also shows high cardiometabolic and respiratory indicators (e.g., asthma ~10%, poor mental health ~13.7%), strengthening the case for combustion-free space heating and ventilation upgrades that also improve indoor air quality. Past statewide programs demonstrate this works: AHFC’s home energy rebates produced ~34% average energy savings and ~30% CO<sub>2</sub> reductions per home, a strong precedent for scaling in Railbelt communities. Prioritizing rebates, no-cost assessments, and contractor “bundles” in these tracts advances measurable outcomes by cutting bills and exposure.

### Public facilities efficiency

Schools, municipal buildings, and health/nonprofit facilities are central services—and, in many places, designated shelters—so cutting their fuel use yields outsized fiscal and health benefits. The state’s plan spotlights rapid, shovel-ready retro-commissioning, lighting/HVAC upgrades, and electrification across public assets (schools, DOT&PF facilities, university buildings) as among the fastest deployable measures, with five-year implementation horizons common. Because Mat-Su tracts like West Meadow Lakes and Gateway exhibit high traffic injury risk and disaster-loss potential, resilient, lower-cost public hubs with stable electric heat and improved ventilation bolster community readiness. Incorporating street lighting efficiency on Glenn Highway segments in/near the Borough is an additional, near-term win highlighted in the plan.

### Expand clean Railbelt power and enable energy resources and advanced technologies that reduce costs for consumers

Grid-side hydropower expansions (e.g., the Dixon Diversion that would add ~190,000 MWh/year and displace ~1.5 bcf of gas annually) reduce system emissions and stabilize prices—benefiting Mat-Su households that face high energy burdens today.

### Improved Outcomes for Overburdened and Underserved Communities

Focusing first on household-level conditions, improved outcomes in Mat-Su stem from cutting high energy burdens, stabilizing bills, and improving indoor environments in renter-dense and cost-stressed tracts. South Wasilla shows a renter share near half of households with very high housing cost burden and elevated uninsured and limited internet access. Targeting pockets with the highest energy burdens—e.g., West Lakes (~7%; 97th pct) and Matanuska River (~8%; 98th pct)—delivers outsized bill relief for households that are also more likely to be uninsured or offline, making offline/mobile program access critical for equitable uptake. In owner-dominant neighborhoods with elevated asthma and poor mental health (e.g., Foothills), ventilation upgrades can reduce triggers.

Community-level outcomes improve when investments also address safety, disaster exposure, and service reliability in at-risk tracts identified for the region. Flood-prone and high-loss areas (e.g., Butte/Lazy Mountain at ~23% of properties with flood risk; Gateway at the 97th percentile for disaster loss) benefit when public facilities and home upgrades are sequenced for resilience (e.g., protected critical loads, risk-aware siting), which preserves access to essential services during outages and extreme events. Several Mat-Su census tracts are flagged as disadvantaged in state planning materials, reinforcing that these combined health, affordability, and risk benefits accrue to at-risk neighborhoods first.

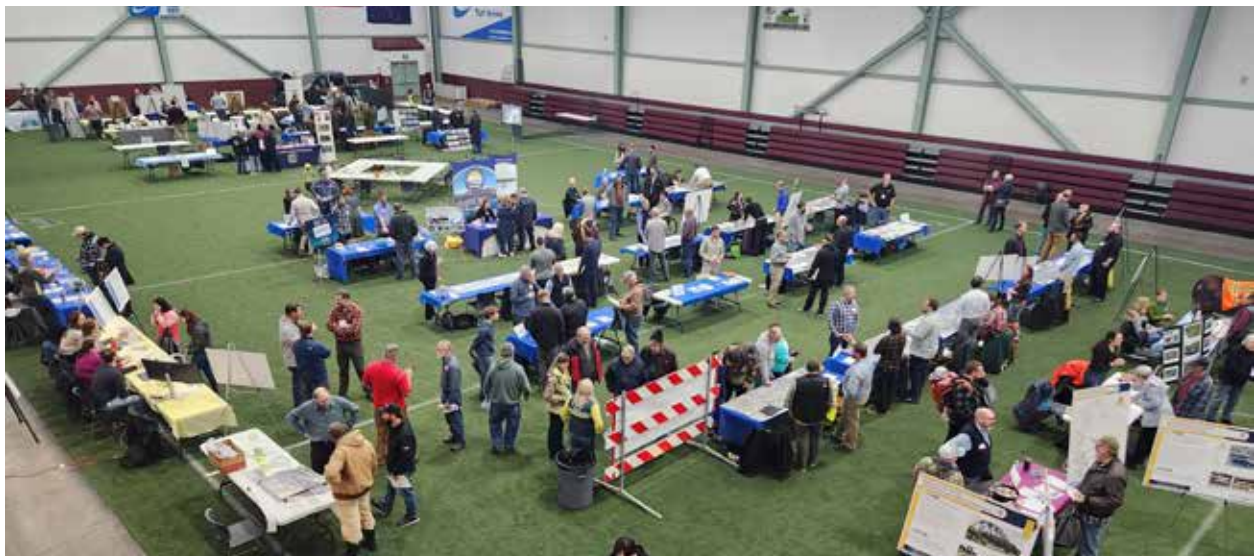
**Benefit (Disbenefit) Quantification or Qualitative Analysis****Targeted home weatherization**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                        | Community Benefits                                                                                                                                 |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate-High    | Per home: ~1–3 mtCO <sub>2</sub> e/yr from reduced fuel oil/propane use and tighter envelopes; 10–30% site energy reduction typical with deeper weatherization (air sealing, insulation, duct sealing, controls). Community-scale upside because residential stationary is a large share of total emissions. | Directly lowers emissions where many at-risk households rely on costly delivered fuels by cutting overall fuel use.                                |
| Energy cost savings | High             | \$300–\$1,200/yr per home from reduced fuel use (ranges depend on fuel type, prices, and envelope quality); savings accumulate over the life of the upgrades.                                                                                                                                                | Largest bill relief flows to high-energy-burden at-risk households; reduces arrears and energy insecurity without requiring equipment replacement. |
| Health benefits     | High             | Better indoor comfort and moisture control from tighter, better-insulated homes; improved ventilation when paired with balanced or exhaust systems; reduced drafts and cold spots support asthma/respiratory symptom reductions and improved mental well-being via thermal stability.                        | Disproportionate gains in tracts with high asthma and mental-health indicators, especially where homes are older or poorly insulated.              |
| Resilience          | Moderate-High    | Tight envelopes reduce outage sensitivity; homes retain heat longer during winter outages or fuel delivery disruptions, helping maintain safe indoor temperatures.                                                                                                                                           | Benefits seniors, families with children, and medically sensitive at-risk residents who are more vulnerable during cold-weather outages.           |
| Disbenefits / risks | Low-Moderate     | Upfront cost, contractor availability, and split-incentives for renters; if air sealing is not paired with appropriate ventilation and moisture management, there is a risk of IAQ or condensation issues; savings are smaller than with full equipment replacement.                                         | Mitigate via no-cost audits, contractor bundles, renter protections, and ventilation standards that keep homes healthy as they are tightened.      |



### Public facilities efficiency (schools, health, municipal)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                | Community Benefits                                                                                    |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Retro-commissioning, lighting, envelope, and HVAC upgrades typically deliver 10–30% savings quickly; deeper efficiency packages can reach 30–40% reductions in fuel and electricity use.             | Cuts community emissions and demonstrates solutions in places at-risk residents use daily.            |
| Energy cost savings | High             | Portfolio effects on municipal budgets; six-figure annual savings across a school district or city campus are common after phased upgrades.                                                          | Savings sustain services in at-risk neighborhoods (libraries, clinics, schools) without raising fees. |
| Health benefits     | High             | Improved ventilation/filtration lowers illness absence; better thermal comfort and more stable indoor temperatures in schools and clinics.                                                           | Tangible benefits for children, elders, and uninsured users of public facilities.                     |
| Resilience          | High             | Facilities can serve as heated shelters with managed loads; lower energy use makes it easier to maintain safe conditions during outages and reduces strain on backup power systems where they exist. | Strengthens outage response where disaster-loss/flood risk are elevated.                              |
| Disbenefits / risks | Low–Moderate     | Capital constraints, construction disruption, and O&M training needs; long-term savings depend on good controls and maintenance.                                                                     | Sequence projects and include staff training; prioritize sites serving at-risk communities first.     |



## Cleaner Railbelt power

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                                               | Community Benefits                                                                                                                                                                                    |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Additional Railbelt hydro and renewable generation displace gas-fired power; hundreds of thousands of MWh/yr can avoid ~50–400+ ktCO <sub>2</sub> e/yr depending on resource mix and dispatch. Grid-scale and distributed storage allow higher renewable shares and reduce reliance on gas peakers during evening and winter peaks. | System-level decarbonization lowers emissions for all customers, with particular benefits for at-risk households and facilities that rely heavily on grid power.                                      |
| Energy cost savings | Moderate–High    | Utility-scale renewables hedge gas price volatility and can lower long-run wholesale costs. Storage helps shave peaks and reduce expensive peaker generation, supporting more stable rates; batteries at key public facilities can reduce demand charges and outage-related costs.                                                  | More stable and potentially lower rates over time help high-energy-burden households and cash-constrained public services, reducing the risk of sudden bill spikes.                                   |
| Health benefits     | Moderate         | Reduced gas peaker operation and smoother grid operation cut emissions at power plants. Fewer outages and voltage disturbances reduce reliance on backup generators, lowering localized diesel exhaust where backup units are common.                                                                                               | Gains accrue to neighborhoods downwind of generation and to at-risk residents who are more sensitive to air pollution and power quality issues.                                                       |
| Resilience          | High             | Grid-scale storage improves reliability during extreme weather and supply disruptions. Batteries at critical sites (clinics, shelters, water/wastewater, communications) can keep refrigeration, heating circulation, pumps, and medical devices online during outages.                                                             | Strong protection for at-risk households and neighborhoods when outages occur, especially where disaster-loss or flood risk is elevated and public facilities act as community hubs.                  |
| Disbenefits / risks | Low–Moderate     | Capital costs, siting and permitting, and long interconnection and procurement timelines; regulatory and rate-design uncertainty around how storage is compensated. If projects are not equitably planned, benefits may accrue mainly to large customers.                                                                           | Mitigate via inclusive planning, consumer protections, and prioritizing storage that supports critical community facilities and high-burden areas—not just large industrial or high-income customers. |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy burden from weatherization.
- More stable indoor temperatures and cleaner indoor air, reducing asthma triggers and stress.
- Budget relief for schools, clinics, and municipal services via efficiency—protects services at-risk residents rely on.
- Stronger outage resilience from public hubs and home technologies that keep critical loads on.
- Easier access when programs offer no-cost audits, on-site/mobile sign-ups, and paper/phone options.
- Local jobs and apprenticeships in audits, HVAC, electrical, and construction that can prioritize hiring.

Potential disbenefits if not designed equitably:

- Upfront costs and credit screens that exclude at-risk participants; savings delayed until projects complete.
- Landlord pass-throughs or rent hikes after upgrades; split-incentive barriers in renter-heavy areas.
- Contractor capacity and rural access gaps leading to waitlists or higher bids.
- Grid constraints and peak load increases; greater outage exposure if electric heat lacks backup.
- Digital divide, language, and paperwork friction limiting uptake.
- Construction disruption at public facilities and along corridors; short-term safety/traffic impacts.
- Rate designs or fixed fees that dilute savings for low-usage/low-income customers.
- Program mistrust or fatigue if outreach isn't culturally competent or if promised benefits don't materialize quickly.

### Path Forward

Matanuska-Susitna's conditions point to a straightforward, high-impact path: make the grid cleaner and more reliable. The place-based SDOH picture shows why this is not one program but a targeted portfolio: renter-dense, high-cost tracts need turnkey weatherization and tenant-safe delivery; health-burdened areas benefit most from better ventilation; flood- and crash-exposed corridors call for resilience-first public anchors. Done together and sequenced well, these actions lower emissions, cut bills, and improve day-to-day conditions—especially for at-risk households—without asking residents to trade comfort or reliability.

Near-term implementation can start where benefits are largest and barriers lowest: (1) launch targeted home upgrades in the highest-energy-burden tracts, paired with contractor “bundles,” renter protections, and mobile/offline enrollment; (2) retrofit schools, clinics, and municipal buildings as community anchors with efficient, electrified systems and backup for critical loads; and advance cleaner Railbelt supply and distributed storage bolster outage resilience.

With a community-first delivery model and clear metrics, the Borough can move quickly from planning to visible, durable results.



# Municipality of Anchorage

Population: 290,761

Census Tracts: 2020000101, 2020000102, 2020000201, 2020000202, 2020000204, 2020000205, 2020000206, 2020000500, 2020000601, 2020000602, 2020000701, 2020000702, 2020000703, 2020000801, 2020000802, 2020000901, 2020000902, 2020001000, 2020001100, 2020001200, 2020001300, 2020001401, 2020001402, 2020001500, 2020001601, 2020001602, 2020001701, 2020001702, 2020001731, 2020001732, 2020001801, 2020001802, 2020001900, 2020002000, 2020002100, 2020002201, 2020002202, 2020002301, 2020002302, 2020002304, 2020002305, 2020002400, 2020002501, 2020002502, 2020002601, 2020002602, 2020002603, 2020002711, 2020002712, 2020002713, 2020002714, 2020002811, 2020002812, 2020002813, 2020002821, 2020002822, 2020002823, 2020002900, 2020980000, 2020980100, 2020980200

This document provides an integrated overview of air quality emissions and social conditions in the Municipality of Anchorage to inform near-term emissions reduction planning and alignment with the State’s Sustainable Energy Action Plan. It synthesizes the 2022 community-wide emissions profile with a multi-tract assessment of social determinants of health (SDOH), highlighting where emissions sources, energy burdens, and environmental exposures converge. The intent is to characterize current conditions and identify the most impactful mitigation pathways for Anchorage, with explicit attention to improving outcomes for vulnerable populations.

Our approach aggregates tract-level data into a community-scale view using three lenses: (1) population-weighted indicators to represent “typical” conditions, (2) range/median values to preserve variability across neighborhoods, and (3) place-based typologies to describe clusters of co-occurring challenges (e.g., older housing, rentership, high traffic exposure, and chronic disease burdens). This structure ensures that city-level priorities do not obscure meaningful differences across Anchorage’s neighborhoods and that at-risk needs are centered from the outset.



Key findings indicate that stationary combustion in buildings is Anchorage’s dominant emissions source, with on-road transportation as the second-largest contributor. These patterns intersect with SDOH in ways that shape both feasibility and benefits: energy cost burdens, indoor air quality, and proximity to traffic corridors are most acute in several core neighborhoods. Accordingly, the strategies advanced in this roadmap emphasize deep efficiency and targeted electrification in residential and multifamily housing; comprehensive retrofits and fuel switching in commercial, industrial, and public facilities; and Railbelt power decarbonization to amplify end-use reductions. Subsequent sections present these strategies, associated benefits and disbenefits, and their implications for delivering durable, measurable improvements—particularly for at-risk households—while advancing Anchorage’s overall emissions reduction goals.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Residential & Multifamily Deep Efficiency + Targeted Electrification
2. Commercial/Industrial (incl. Public Facilities) Retrofits & Fuel Switching
3. Railbelt Power Decarbonization to Enable Beneficial Electrification

These three strategies directly address Anchorage’s dominant emissions source—on-site fuel combustion in buildings—while enabling durable, system-level reductions. Deep residential and multifamily efficiency with targeted electrification reduces the largest single load and yields immediate, measurable benefits. Comprehensive retrofits and fuel switching in commercial, industrial, and public facilities deliver substantial, cost-effective reductions across high-consumption assets. Railbelt power decarbonization then amplifies both by lowering the carbon intensity of electricity, stabilizing energy costs, and increasing the emissions abatement realized from electrified end uses. Together, they provide the highest, most reliable mitigation potential and strengthen outcomes for at-risk communities.

## Emissions Data Overview

Total Modeled Emissions: 3,767,028 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (79.46%)

- Residential Sector (29.02%)
  - Natural gas: 984,133.27 mt CO<sub>2</sub>e (26.12%).
  - Electricity: 62,798.65 mt CO<sub>2</sub>e (1.67%).
  - Residual Fuel Oil No. 5: 37,947.72 mt CO<sub>2</sub>e (1.01%).
  - Propane: 8,073.14 mt CO<sub>2</sub>e (0.21%).
  - Wood & residuals: 265.86 mt CO<sub>2</sub>e (0.01%).
- Commercial Sector (25.88%)
  - Natural gas: 532,937.57 mt CO<sub>2</sub>e (14.15%).
  - Distillate Fuel Oil No. 1: 266,455.30 mt CO<sub>2</sub>e (7.07%).
  - Electricity: 154,357.64 mt CO<sub>2</sub>e (4.10%).
  - Propane: 20,341.01 mt CO<sub>2</sub>e (0.54%).
  - Wood & residuals: 739.51 mt CO<sub>2</sub>e (0.02%).
- Industrial Sector (24.56%)
  - Natural gas: 923,522.22 mt CO<sub>2</sub>e (24.52%).
  - Distillate Fuel Oil No. 1: 1,552.33 mt CO<sub>2</sub>e (0.04%).
  - Distillate Fuel Oil No. 2: 13.30 mt CO<sub>2</sub>e (0.00%).

**Transportation (20.54%)**

By fuel type:

- Motor gasoline: 644,989.65 mt CO<sub>2</sub>e (17.12%).
- Diesel: 128,893.73 mt CO<sub>2</sub>e (3.42%).
- Electricity: 6.90 mt CO<sub>2</sub>e (~0.00%).

By vehicle type (within transport):

- Trucks: 641,842.21 mt CO<sub>2</sub>e (82.94% of transport emissions)
- Passenger vehicles: 131,154.29 mt CO<sub>2</sub>e (16.95%)
- Motorcycles: 893.78 mt CO<sub>2</sub>e (0.12%)

**Electricity Generation**

- Electricity consumption: 2,117,714.86 MWh
- Generation sources:
  - Natural gas: 952,971.69 MWh → 195,549.79 mt CO<sub>2</sub>e (90.05% of generation emissions).
  - Biomass: 63,531.45 MWh → 21,613.40 mt CO<sub>2</sub>e (9.95%).
  - Wind: 190,594.34 MWh → 0 mt CO<sub>2</sub>e
  - Hydro: 148,240.04 MWh → 0
  - Nuclear: 741,200.20 MWh → 0

**Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%**

- Not included in this dataset.

**Key Takeaways**

- Dominance of stationary combustion. Approximately four-fifths of total emissions arise from fuel burned in buildings and facilities, underscoring buildings as the community's primary emissions domain.
- Balanced contribution among building sub-sectors. Residential (~29%), commercial (~26%), and industrial (~25%) sources each contribute materially; progress requires attention to all three rather than a single lead sector.
- Natural gas as the leading driver. Natural gas use across residential, commercial, and industrial facilities constitutes the single largest share of total community emissions.
- Continuing role of heating oil in commerce. Distillate fuel oil remains a notable contributor in the commercial sector, indicating pockets of oil-reliant space and process heating.
- Relatively modest scope 2 (purchased electricity) signal on the demand side. Direct emissions attributed to electricity consumption in buildings are smaller than on-site fuel combustion, though they remain material.
- Gas-heavy generation mix. The upstream electricity generation profile associated with local consumption is predominantly natural gas, with a smaller biomass component; non-emitting sources (e.g., wind, hydro) contribute energy but little or no reported CO<sub>2</sub>e.
- Transportation at roughly one-fifth of the total. On-road transportation accounts for about 20% of emissions, making it the second-largest category after stationary sources.
- Fleet composition matters. Motor gasoline is the principal transport fuel, and trucks represent the majority of on-road emissions, outweighing passenger vehicles.
- Minimal current impact from transport electrification. Electricity use in transportation is presently negligible in the inventory, indicating early adoption levels and limited near-term emissions displacement.
- Implications for planning focus. Emissions intensity is likely to vary with building age and type, heating fuel, and vehicle mix; these variations should inform phasing, outreach, and equity considerations in subsequent roadmap steps (without yet prescribing specific strategies).

## Social Determinants of Health

To reflect conditions across Anchorage without losing neighborhood diversity, we used a three-lens approach on the tract-level indicators provided:

1. Population-weighted community snapshot. For measures that logically aggregate (e.g., asthma prevalence, renter share, uninsured rate), interpret the Anchorage picture as a weighted center of gravity while noting spread.
2. Range + median. For metrics that vary widely or have zeros/missing values (e.g., life expectancy marked “0” in some tracts), use min/median/max across tracts to surface inequities and data anomalies.
3. Typologies. Group tracts into practical “place types” based on co-occurring social and environmental factors (poverty + renters + older housing + hazard proximity, etc.). This keeps extreme conditions visible and avoids over-averaging.

## Environmental Exposure & Risk

- Disaster risk is broadly elevated. Several core and institutional areas show very high annualized disaster loss percentiles (e.g., Midtown ~96th, University Area ~98th, Downtown Core ~91st), while outlying Eagle River/Peters Creek ranges from moderate to high. Flood-risk shares vary dramatically (Ptarmigan ~35% properties at risk; University & Cheney Lake ~40%).
- Legacy and industrial burdens concentrate in the urban core. Tracts around Government Hill, Mountain View/Ship Creek, Merrill Field, Midtown, West Fairview, Spenard score at or near the top deciles for hazardous sites proximity, RMP facilities, and toxic air releases, alongside older housing and very high airport/road proximity.
- Diesel PM & air toxics are modest in outer areas but higher in the core (e.g., multiple tracts near airports/corridors report diesel PM ~0.5–0.77 and air toxics risk bands at 50–60).
- Formerly Used Defense Sites (FUDS) appear in some tracts (e.g., Government Hill; South/North Fireweed), which often correlate with older housing and infrastructure.

Implications: Environmental quality and physical risk are not uniform; corridor- and airport-adjacent core tracts face combined exposure (noise, air toxics, road safety, flood risk) that compound social vulnerability.

## Health status & life expectancy

- Chronic disease & mental health burdens cluster in core tracts. Asthma frequently >90th percentile in Russian Jack, Midtown, Spenard, Campbell Park West/East; diabetes and hypertension also spike in these areas. Poor mental health is ~90–98th percentile in multiple core tracts.
- Life expectancy splits sharply. Low life expectancy flags are extreme in Downtown Core (~67 years), Mountain View (~69), Merrill Field (~70–70s), West Fairview (~72), Spenard (~71), while Turnagain/Upper Eagle River report ~81–82.
- In outer Eagle River/Chugiak and hillside/foothill tracts, chronic disease rates are generally lower and life expectancy higher.

Implications: Place-based disparities are pronounced; the same city contains tracts with 15+ year gaps in expected lifespan.

## Socioeconomics, housing, digital access

- Poverty & rentership concentrate in the core. Mountain View tracts, West Fairview, Merrill Field, Midtown, Downtown Core show <200% Federal Poverty Level (FPL) shares ~30–68% and renters ~55–86%; housing cost burden in many of these exceeds 40–52% of households.
- Education & unemployment are also more challenging in core tracts (no-HS rates frequently >10%; unemployment often >6–8%).

- Mobile homes cluster notably in Merrill Field (~28%) and parts of Spenard (~19%) and Muldoon (~14%), often paired with high energy and transportation burdens.
- Limited internet access is striking in select core tracts (South Fireweed ~30%, Downtown Core ~25%, Mountain View ~15–27%) despite being much lower in outlying areas.
- Age structure is bifurcated. Youth shares are very high in Mountain View (up to ~40–43% under 17), whereas older adult shares are high in Turnagain, Rogers Park/Tudor, Bootleggers Cove.

Implications: Economic precarity, renter instability, and digital gaps intersect with environmental exposures in the core, while outlying neighborhoods tend to be higher-income, older owner-occupied, with better baseline health.

### Transportation insecurity & road safety

- Access scores are negative to highly negative across most core tracts (e.g., Downtown Core, Midtown, Russian Jack, West Fairview, Spenard), indicating limited affordable, reliable access to destinations.
- Cost burdens & safety: Core areas see high transportation cost shares and elevated traffic fatality rates (e.g., Midtown ~20.8 per 100k, Merrill Field ~11.4, West Mountain View ~6.5, West Fairview ~7.2), amplifying vulnerability.

Implications: Transportation cost and safety risks intensify social vulnerability and can hinder equitable participation in emissions reduction programs.

### Neighborhood typologies (why conditions differ within one community)

#### 1. Core Energy-Burdened Urban Tracts

Examples: Mountain View (West/East), Merrill Field, Midtown, West Fairview, Spenard, Government Hill.

Signature: High poverty & rentership; older housing stock; high hazard/RMP proximity; high airport/road proximity; high asthma/diabetes/poor mental health; lower life expectancy; high transport cost & fatalities; notable internet gaps and Limited English Proficiency (LEP) pockets.

Why: Historical siting near freight/industrial corridors and airports, older multifamily stock, and cumulative infrastructure burdens that overlap with economic precarity.

#### 2. Stable/Elevated-Income Westside & Coastal Core

Examples: Turnagain, Bootleggers Cove/Westchester, Rogers Park/Tudor (with caveats of high chronic disease markers in some).

Signature: Higher home values; more owners; older populations; still high proximity to roads/airport and older housing; some tracts show unexpectedly high hypertension/cancer despite better socioeconomic conditions.

Why: Desirable locations with legacy housing; age structure and clinical risk factors raise chronic disease measures even where poverty is lower.

#### 3. Northeast Corridor Mixed-Vulnerability

Examples: Ptarmigan, Wonder Park, Russian Jack, NW/NE Muldoon, Cheney Lake, Baxter, University Area, Scenic Foothills, Muldoon.

Signature: Mix of moderate to high flood risk (some ~33–49–40% properties), older housing, mid-to-high renter shares, varied income/education; health outcomes range from moderate to poor; transportation access often negative.

Why: Transitional corridor with diverse housing types, proximity to arterials, pockets of industrial/hazard sites, and uneven access to services.



#### 4. Eagle River/Chugiak & Outlying North

**Examples:** Downtown Eagle River, Eagle River, Lower/Upper Eagle River Valley, Chugiak, Peters Creek/Eklutna.

**Signature:** Lower poverty; more owners; better life expectancy (except data gaps); lower diesel PM; lower renter share; but non-trivial flood/disaster risk and some tracts with airport/road proximity and older housing (Chugiak).

**Why:** Suburban pattern with newer housing in places, stronger incomes, and distance from heavy industrial clusters—yet still exposed to regional hazards (flooding, wildfire smoke, earthquakes, extreme precipitation).

#### Intersection with Emissions Reduction Planning

- Equity & sequencing
  - High-burden core tracts (Mountain View, Midtown, Merrill Field, West Fairview, Spenard, Government Hill) combine air toxics, traffic, flood risk, and socioeconomic vulnerability. Any sustainability action planning should anticipate higher participation barriers (cost, rentership, digital access, language access, trust) and higher immediate health co-benefit potential (respiratory and mental health). These areas warrant front-loaded engagement and benefit delivery.
- Health co-benefits potential
  - Elevated asthma/diabetes/hypertension suggests outsized air-quality and indoor-environment payoffs from pollution-reducing measures (e.g., future building improvements, cleaner transport).
  - Mental health burden is consistently high in core tracts; programs that reduce noise/traffic stressors and improve neighborhood amenities may have indirect mental-health co-benefits.
- Housing & tenure realities
  - With renters often >60–80% in parts of the core, split incentives and housing stability will affect who benefits from building-side emission reductions and how benefits persist. Mobile-home clusters (Merrill Field, Spenard, Muldoon) flag non-standard housing and potential energy-burden sensitivity.
- Infrastructure & siting
  - Hazardous site/RMP proximity and airport/arterial adjacency mean that siting and phasing of any future facilities or construction impacts need extra care in core EJ areas to avoid compounding cumulative risk.
  - Flood-prone tracts (Ptarmigan; University/Cheney Lake; parts of NE Anchorage) will influence resilience co-design, right-of-way choices, and lifecycle cost assumptions for any capital deployment.
- Transportation access & safety
  - Negative access scores and high fatality rates in urban core tracts signal that pollution-reducing mobility changes must contend with safety and affordability to realize behavioral uptake. Cost burden indicators suggest price sensitivity to any mode shift that relies on new household spending.
- Demographics & service design
  - Youth-heavy tracts (Mountain View) and older-adult-heavy tracts (Turnagain, Rogers Park/Tudor, Bootleggers Cove) imply different risk perceptions, communication channels, and co-benefit framings.
  - LEP pockets (e.g., Merrill Field, core areas) and limited internet access highlight the need for in-language, offline, and community-based outreach.
- Regional hazards backdrop
  - Citywide high disaster-loss percentiles (esp. core institutional tracts) and widespread flood risk indicate that resilience framing will be essential alongside pollution reduction, even where baseline socioeconomics are favorable (e.g., westside coastal tracts).

## Bottom line

Anchorage exhibits sharp intra-city disparities: core tracts shoulder stacked social and environmental burdens with lower life expectancy and higher chronic disease; outlying and westside tracts are healthier and wealthier but still face regional environmental hazards (flooding, disaster risk, airport/road adjacency). This diversity argues for a place-typed, equity-first approach to planning that pairs pollution reduction with safety, affordability, and housing tenure awareness, ensuring benefits reach and persist where burdens are greatest.

## Mitigation Strategies

### Deep efficiency and heating upgrades in homes (weatherization + targeted electrification)

Prioritize whole-home weatherization and high-efficiency heating replacements where energy burden, rentership, asthma, and older housing stock co-locate. In Anchorage's core neighborhoods, combining air-sealing/insulation, smart controls, heat-pump water heaters, and (case-by-case) cold-climate air-source heat pumps can sharply reduce on-site fuel use—the single largest emissions driver—while lowering bills and improving indoor air quality. Use enrollment “navigators,” low- or no-cost assessments, and landlord pathways so benefits reach renters and manufactured-home residents; stack federal rebates with utility offers and arrange on-bill or tariffed repayment to avoid up-front cost barriers. This mirrors the plan's emphasis on scaling residential weatherization and beneficial electrification with documented savings and at-risk benefits.

### Public-sector retrofits and retro-commissioning at scale (schools, state/municipal assets)

Accelerate packages of low-disruption upgrades in schools, health and civic buildings, and university/state facilities—retro-commissioning, controls optimization, high-efficiency boilers or heat pumps, LED and ventilation upgrades—sequenced for quick payback and reliability. These assets are high-consumption, highly visible, and frequently located near at-risk areas; cutting fuel use reduces operating costs (protecting services) and delivers local co-benefits (air quality, thermal comfort) where residents spend significant time. The state priority plan identifies this track as “implementation-ready,” with quantified reductions and a clear path through existing capital and maintenance programs.

### Railbelt power decarbonization to enable “beneficial electrification”

Advance grid-side projects that displace gas-fired generation and improve reliability—e.g., new firm renewable capacity and storage (such as hydro expansions) plus community generation and enabling transmission. As the Railbelt cleans up, shifting end-uses from on-site fuel to efficient electric (space/water heating, commercial processes) yields larger lifecycle cuts. For beneficial outcomes, tie community-sited projects to bill-stabilization commitments and low-income customer programs so households actually feel the savings. The plan's electric-generation portfolio (e.g., large hydro diversions, community gen & T&D upgrades) is expressly designed to cut Railbelt emissions and lower exposure to volatile gas costs that disproportionately strain low-income budgets.

### Clean, safer mobility where exposure and costs are highest

Target on-road emissions by focusing first on corridors and fleets that dominate fuel use and affect at-risk neighborhoods: medium/heavy trucks, high-injury urban arterials, and delivery/municipal fleets. Pair efficient operations (anti-idling, routing, driver training) with electrification where duty cycles fit, and build charging in community-serving locations (multifamily hubs, employment centers) so access is equitable by design. For ports and logistics nodes, shore-power and equipment electrification reduce localized exposure to diesel exhaust while cutting CO<sub>2</sub>e. The state plan's EVSE build-out, port electrification, and diesel-reduction programs provide ready models and funding pathways; prioritize siting and workforce opportunities to maximize health and cost benefits.

**Organics diversion and methane control (community composting & landfill gas)**

Reduce short-lived air pollutants by diverting organics (food/yard waste) from landfills and capturing methane where diversion is not yet feasible. Regionally, composting programs can be stood up quickly with job creation and lower solid-waste costs—benefits that matter in at-risk neighborhoods—while landfill-gas capture or co-generation projects convert an existing liability into energy and heat for local uses. These measures in the priority plan show substantial, quantifiable reductions and are implementable alongside education, procurement standards (for compost use), and utility partnerships.

**Improved Outcomes for Overburdened and Underserved Communities**

Targeted implementation of building upgrades, cleaner power, and low-emission mobility can materially improve outcomes for at-risk households in Anchorage. In homes and multifamily buildings, whole-home weatherization and high-efficiency heating reduce on-site fuel use—the region’s dominant emissions source—lowering monthly energy costs and improving indoor air quality linked to asthma and other respiratory conditions. In public buildings (schools, clinics, civic spaces) that serve at-risk neighborhoods, retrofits enhance thermal comfort and ventilation while protecting public services through reduced operating costs. As the Railbelt power mix decarbonizes and becomes more price-stable, pairing end-use electrification with bill protections (e.g., income-qualified rates, on-bill financing that nets savings on day one) can further cut exposure to fuel price volatility that disproportionately strains low-income budgets.

Mobility measures focused on high-injury corridors, diesel-intensive fleets, and community-accessible charging can reduce local pollution and traffic harms where at-risk residents live, work, and travel. Port and freight electrification, anti-idling, and route optimization lessen diesel exhaust near core neighborhoods; safer street designs and affordable, reliable options (transit, shared mobility) improve access to jobs, education, and healthcare. Complementary organics diversion and methane control add near-term sustainability benefits while supporting local jobs and healthier neighborhood environments. Across all domains, prioritizing at-risk participation (multilingual outreach, navigator support, renter/landlord pathways, consumer protections) and tracking distributional metrics—energy-burden reduction, indoor air quality improvements, crash/injury reductions, and bill stability—helps ensure that emissions reduction investments translate into concrete, durable gains in household health, affordability, and resilience.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Deep efficiency & heating upgrades in homes (weatherization + targeted electrification)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                                                                 | Community Benefits                                                                                         |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Homes $\approx$ 1.09 Mmt CO <sub>2</sub> e of total baseline. Typical whole-home packages (air sealing/insulation, controls, heat-pump water heater, targeted space-heating upgrades) can reduce end-use fuel 20–40% per home; with prioritized uptake in older stock, near-term community impact could reach $\sim$ 10–20% of residential emissions. | Direct benefits in renter-heavy, high-burden tracts; prioritization narrows exposure and cost disparities. |
| Energy cost savings | High             | Typical bill reductions 15–30% from envelope + controls; >30% where shell conditions are poor or fuel is expensive. Day-one positive cash flow feasible with stacked incentives/on-bill.                                                                                                                                                              | Reduces energy burden for at-risk households; design matters (no/low upfronts, consumer protections).      |
| Health benefits     | High             | Improvements in IAQ, thermal comfort, and moisture control linked to asthma/respiratory outcomes; combustion exposure drops with efficient equipment and electrified water/space heating.                                                                                                                                                             | Targets co-occurring asthma and older housing in at-risk areas; measurable household-level health gains.   |
| Resilience          | Moderate–High    | Weatherized homes sustain safer temperatures during outages/extreme cold; efficient equipment lowers peak fuel needs.                                                                                                                                                                                                                                 | Improves shelter-in-place conditions and bill stability for vulnerable households.                         |
| Disbenefits / risks | Moderate         | Split incentives in rentals; improper sizing/installation in cold climates; landlord pass-throughs. Mitigate with quality assurance, tenant protections, and fuel-appropriate designs.                                                                                                                                                                | Ensure upgrades do not trigger rent hikes or displacement; offer landlord pathways tied to affordability.  |





### Public-sector retrofits & retro-commissioning (schools, municipal/state assets)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                | Community Benefits                                                                                |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Public campuses are high-load facilities; 15–30% energy reductions common for RCx/controls/LED/HVAC packages; aggregated programs can deliver meaningful cuts in stationary emissions while demonstrating solutions. | Many facilities serve or are located near at-risk neighborhoods; visible benefits accrue locally. |
| Energy cost savings | High             | Portfolio paybacks often 3–8 years for RCx/lighting/controls; savings recycle into services (schools, clinics, community centers).                                                                                   | Protects essential services and operating budgets in community-serving institutions.              |
| Health benefits     | High             | Better ventilation, filtration, and thermal comfort improve learning and health outcomes; reduces exposure in spaces where residents spend time.                                                                     | Benefits concentrate where at-risk residents use public facilities daily.                         |
| Resilience          | Moderate–High    | Controls, envelope, and equipment upgrades improve uptime and indoor conditions during events; critical facilities can add backup/heat recovery.                                                                     | Strengthens community shelters and service continuity in at-risk areas.                           |
| Disbenefits / risks | Low–Moderate     | Construction disruption; project delivery risk; persistence of savings without O&M training.                                                                                                                         | Plan phasing around school calendars; pair with local workforce pathways.                         |

### Railbelt power decarbonization (generation + transmission/storage enablement)

| Outcome             | Potential Impact                        | Quantitative / Qualitative Assessment                                                                                                                                                                                                                | Community Benefits                                                                        |
|---------------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate (standalone) / High (enabling) | Upstream generation emissions are a modest share today, but cleaner grid amplifies end-use electrification benefits across buildings/transport; long-term system effect can unlock double-digit percent reductions when coupled with load switching. | Lowers lifecycle emissions of measures deployed in at-risk housing and fleets.            |
| Energy cost savings | Moderate                                | Portfolio can hedge gas price volatility; levelized costs depend on resource mix and financing. Over time, system costs can stabilize or fall.                                                                                                       | Bill stability matters most; pair with income-qualified rates to ensure realized savings. |
| Health benefits     | Moderate                                | Regional air-quality co-benefits from reduced combustion at generators; indoors benefits arrive via electrified end uses made cleaner by the grid.                                                                                                   | Indirect but meaningful when paired with building upgrades in at-risk areas.              |
| Resilience          | Moderate–High                           | Diversified supply + storage improves reliability, reduces outage risk; supports critical facilities.                                                                                                                                                | Reliability gains disproportionately help at-risk communities with fewer backup options.  |
| Disbenefits / risks | Moderate                                | Capital intensity; siting/transmission concerns; rate design could shift costs inequitably.                                                                                                                                                          | Use affordability guardrails and community benefits to avoid regressive impacts.          |

### Clean, safer mobility (truck/fleet focus, high-injury corridors, community-accessible charging)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                              | Community Benefits                                                                                                                   |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | On-road $\approx 0.77$ Mmt CO <sub>2</sub> e. Targeted actions on medium/heavy trucks, municipal/delivery fleets, anti-idling, and corridor operations can cut 5–15% of on-road near-term; additional reductions with incremental electrification. | Focus on corridors adjacent to at-risk neighborhoods for maximum local benefit.                                                      |
| Energy cost savings | Moderate         | Fleet electrification/efficiency lowers fuel and maintenance; benefits vary by duty cycle and charging costs.                                                                                                                                      | Lower freight/service costs can translate to community benefits; ensure access to affordable charging for multifamily at-risk areas. |
| Health benefits     | High (local)     | Diesel PM/NO <sub>x</sub> reductions near homes, schools, and workplaces; safety upgrades on high-injury corridors reduce crashes and injuries.                                                                                                    | Direct exposure reductions and safety gains where at-risk residents live and travel.                                                 |
| Resilience          | Moderate         | Diversified fuel mix, idle-reduction, and reliable transit improve mobility during disruptions; community charging adds redundancy.                                                                                                                | Enhances access to services and jobs during adverse events for at-risk households.                                                   |
| Disbenefits / risks | Moderate         | Winter range, charger reliability, upfront costs; risk of unequal charging access; construction impacts on corridors.                                                                                                                              | Prioritize siting, tariff design, and winterized equipment; maintain transit affordability.                                          |

### Organics diversion & methane control (composting + landfill gas capture/use)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                | Community Benefits                                                                        |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Methane abatement offers high near-term emissions reduction value; diversion plus capture can deliver material SLCP cuts even if share of total is smaller than buildings/transport. | Benefits accrue citywide; siting and jobs can be targeted to at-risk communities.         |
| Energy cost savings | Low–Moderate     | LFG-to-energy can offset fuel/electric use at facilities; compost markets can reduce municipal landscaping costs; household bill effects limited.                                    | Job creation and potential utility savings can indirectly benefit at-risk neighborhoods.  |
| Health benefits     | Moderate         | Reduced odors and vectors; improved local environmental conditions; compost supports urban greening/soil quality.                                                                    | Greening and nuisance reduction can improve daily conditions in at-risk areas.            |
| Resilience          | Moderate         | Local soil amendments enhance stormwater management; LFG projects can provide local heat/power co-benefits.                                                                          | Neighborhood greening and flood management support resilience.                            |
| Disbenefits / risks | Low–Moderate     | Contamination in organics stream; siting/odor concerns; project performance variability.                                                                                             | Engage residents early on siting and benefits; robust O&M and education reduce nuisances. |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower energy burden from efficiency, fuel switching, and bill-protection designs
- Better indoor air quality and thermal comfort (fewer asthma triggers, safer winter temps)
- Improved street safety and reduced diesel exposure along high-injury corridors
- More reliable essential services (schools, clinics) through public-facility upgrades
- Bill stability from reduced dependence on volatile fuels and clearer rate designs
- Local job pathways and contractor development tied to priority projects
- Resilience gains: weatherized homes, backup-ready community facilities, greener stormwater
- Easier access via multilingual outreach, navigators, and renter/landlord participation paths

Potential disbenefits if not designed equitably:

- Rent increases or displacement if upgrades aren't paired with tenant protections
- Regressive bill impacts if rate or fee changes aren't income-aware
- Unequal access to benefits (e.g., charging, rebates) without targeted siting and eligibility
- Construction and traffic disruptions concentrated in already burdened areas
- Siting concerns (odor, noise, visual) for waste/energy projects near at-risk neighborhoods
- Cold-climate performance gaps or poor installs leading to comfort/reliability issues
- Maintenance and O&M burdens falling on under-resourced property owners/managers
- Administrative barriers (paperwork, credit checks, digital access) limiting program uptake

### Path Forward

In sum, Anchorage's emissions profile and social conditions point to a clear organizing principle for near-term action: prioritize measures that reduce on-site fuel use in buildings while enabling system-level decarbonization. Deep efficiency and targeted electrification in residential and multifamily housing, comprehensive retrofits and fuel switching in commercial/industrial and public facilities, and Railbelt power decarbonization together deliver the largest, most reliable reductions, with strong co-benefits for health, affordability, and resilience. These pathways align with the EPA framework and are well suited to the region's cold weather, fuel mix, and building stock.

Centering improved outcomes for at-risk households strengthens both equity and effectiveness. Targeting renter-dense, energy-burdened neighborhoods and high-use public facilities can lower bills, improve indoor air quality, and enhance service reliability where needs are greatest, while cleaner electricity amplifies the benefits of each end-use upgrade over time. Implementation should pair technical measures with enabling policies—tenant and consumer protections, navigator support, data-driven siting, and income-qualified rate design—to ensure benefits accrue durably and avoid unintended harms.

As Anchorage advances from assessment to implementation, a concise monitoring framework—tracking sectoral emissions reductions, energy-burden changes, indoor air quality improvements, corridor safety metrics, and program participation by neighborhood—will provide accountability and allow adaptive management. With disciplined execution and attention to place-based needs, the recommended strategies can deliver measurable progress toward Anchorage's sustainable energy goals while improving everyday conditions for the communities most affected by current energy and environmental burdens.





Population: 1,123  
Census Tract: 2230000100

Skagway, Alaska, is a small but strategically important community whose energy use and social conditions Skagway, Alaska is a small, remote community whose energy systems, housing conditions, and transportation patterns play an outsized role in shaping local criteria pollutants and greenhouse gas emissions, as well as community well-being. With just over 1,100 residents, emissions are concentrated in a limited number of sources—primarily residential heating fuels, truck-based transportation, and petroleum-supported electricity generation. These patterns reflect Skagway’s cold climate, reliance on delivered fuels, and role as a regional transportation and service hub.

At the same time, social and health conditions influence how energy and infrastructure systems are experienced across the community. Skagway has an aging population, elevated prevalence of chronic health conditions, and a housing stock that includes a significant share of older and mobile homes. Flood risk and increasing exposure to extreme weather further heighten the importance of reliable, efficient, and resilient energy systems. While housing cost burden and income inequality are lower than previously assumed, unemployment, energy costs, and access to services remain meaningful considerations for many households.

This roadmap brings together emissions data and social determinants of health to identify practical, high-impact strategies for reducing emissions while improving everyday conditions for residents. By focusing on the largest sources of emissions and aligning actions with housing quality, health sensitivity, and infrastructure resilience, Skagway can pursue a path that strengthens affordability, reliability, and long-term community stability.

### Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Residential Heating Efficiency & Fuel Transition
2. Community Renewable Energy & Resilient Microgrids
3. Transportation Efficiency & Fleet Transition



Together, these three strategies address Skagway's largest emission sources—residential heating, petroleum-based electricity, and truck-heavy transport—while delivering immediate, visible benefits in cost savings, health, and resilience for at-risk households.

## Emissions Data Overview

Total Modeled Emissions: 8,179 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (64.61 %)

- Residential Sector (46.75%)
  - Residual Fuel Oil No. 5: 3,708.98 mt CO<sub>2</sub>e (~45.35 % of total community emissions)
  - Electricity: 80.28 mt CO<sub>2</sub>e (~0.98 %)
  - Natural Gas: 11.55 mt CO<sub>2</sub>e (~0.14 %)
  - Propane: 11.91 mt CO<sub>2</sub>e (~0.15 %)
  - Wood & wood residuals: 11.05 mt CO<sub>2</sub>e (~0.14 %)
- Commercial Sector (17.85%)
  - Distillate Fuel Oil No. 1: 1,129.31 mt CO<sub>2</sub>e (~13.81 % of total)
  - Propane: 86.21 mt CO<sub>2</sub>e (~1.05 %)
  - Electricity: 241.56 mt CO<sub>2</sub>e (~2.95 %)
  - Wood & wood residuals: 3.13 mt CO<sub>2</sub>e (~0.04 %)
- Industrial Sector: 0%

### Transportation (35.39%)

By fuel type in transportation

- Motor Gasoline: 2,120.44 mt CO<sub>2</sub>e (~25.93 % of total emissions)
- Diesel Fuel: 774.43 mt CO<sub>2</sub>e (~9.47 %)
- Electricity (for electric vehicles etc.): 0.04 mt CO<sub>2</sub>e (effectively negligible)

By vehicle type

- Trucks: 2,620.90 mt CO<sub>2</sub>e (~90.53 % of the transportation sector) a
- Passenger vehicles: 266.48 mt CO<sub>2</sub>e (~9.21 %)
- Motorcycles: 7.53 mt CO<sub>2</sub>e (~0.26 %)

### Electricity Generation

Total electricity used: 12,418.09 MWh

Breakdown of electricity sources:

- Hydro: 11,300.46 MWh → 0.00 mt CO<sub>2</sub>e (i.e. negligible emissions)
- Petroleum (i.e. fossil fuel generation): 1,117.63 MWh → 321.88 mt CO<sub>2</sub>e (100 % of the generation emissions)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- The largest single source of emissions is residential heating via Residual Fuel Oil No. 5, accounting for nearly half of total emissions (~45 %).
- Commercial heating and operations also rely significantly on fossil fuels (e.g. distillate fuel oil).
- Transportation is a major contributor — over one-third of emissions — dominated by trucks using gasoline and diesel.
- Electricity generation contributes a smaller share, especially where hydro is part of the mix; fossil fuel-based electricity still causes a measurable emissions burden.

## Social Determinants of Health

### Environmental Conditions

- Extreme Weather & Disaster Risk
  - Anticipated changes in extreme weather are high (index score 71.59), indicating above-average exposure to environmental hazards.
  - Annualized disaster loss is moderate at \$350,270, ranking in the 19.32nd percentile nationally.
  - Flood risk is significant: 21% of properties face flood risk, placing Skagway in the 86th percentile nationally.
- Pollution & Toxic Exposure
  - Diesel particulate matter (PM) exposure is low but non-zero (0.01).
  - Air toxics cancer risk is elevated (score 9.00, high relative burden).
  - Proximity to hazardous sites is moderate (47.73rd percentile), but RMP facilities, Superfund sites, and hazardous waste proximity are effectively absent.
- Environmental Infrastructure & Sites
  - Toxic releases to air are low (6th percentile).
  - Older housing stock is prevalent:
    - Pre-1980 housing affects 42% of occupied units (61st percentile).
    - Pre-1960 housing accounts for 28% of occupied units.
  - Moderate proximity to high-volume roads (49th percentile) and airports (23rd percentile).
  - Presence of formerly used defense sites indicates legacy environmental risk.

**Implications:** Skagway faces meaningful environmental exposure driven primarily by extreme weather and flood risk, compounded by an aging housing stock that may be poorly equipped to withstand environmental stress. While industrial and hazardous facility risks are minimal, elevated air toxics cancer risk and older buildings increase vulnerability to both severe weather related impacts and indoor environmental health challenges.

### Public Health Indicators

- Chronic Conditions
  - Asthma prevalence (3.45%) and diabetes (3.50%) are modest, below national averages but still meaningful in small populations.
  - Cancer prevalence (2.25%) and hypertension (14.75%) reflect mid-range risk levels.
  - Poor mental health prevalence is 4.85%, representing a significant burden for a small community.
- Mortality & Life Expectancy
  - Average life expectancy is 80.8 years, above the national average.
  - Low life expectancy ranks in the 26th percentile, indicating comparatively favorable outcomes overall.
  - Heart disease prevalence is relatively low (25th percentile).

**Implications:** Despite relatively strong life expectancy, Skagway exhibits elevated prevalence of multiple chronic conditions, including asthma, cancer, hypertension, diabetes, and poor mental health. These conditions increase sensitivity to air quality, housing quality, and extreme weather events, underscoring the importance of emissions reduction strategies that also reduce pollution and improve indoor environmental conditions.

### Socioeconomic Factors

- Income, Employment, & Education
  - Population below 200% of the federal poverty line is 15.15% (23rd percentile).
  - Unemployment is high (7.9%), ranking in the 87th percentile nationally.
  - Educational attainment is mixed: 11.5% lack a high school diploma (86th percentile).
  - GINI index is 0.34, ranking in the 13th percentile nationally.

- **Housing & Energy**
  - Housing cost burden is low relative to national norms (15.1%, 9th percentile).
  - Median home value is \$338,500 (75th percentile).
  - Energy burden is moderate (3% average; 61st percentile).
  - Mobile homes represent 7.1% of housing stock (78th percentile), indicating exposure to housing quality and environmental risks.
- **Access & Demographics**
  - Uninsured rate is 13.4% (54th percentile).
  - 10.9% lack internet access (46th percentile).
  - Aging population: 12.9% are 65+ (83rd percentile).
  - Disability prevalence is 14.7% (70th percentile).
  - Limited English proficiency is low in absolute terms (1.05%) but moderate in percentile ranking.

**Implications:** Skagway's socioeconomic profile reflects moderate poverty but elevated unemployment, educational gaps, and a growing older population, combined with housing stock characteristics that increase environmental sensitivity. While income inequality and housing cost burden are lower than previously described, energy costs, aging demographics, and housing quality remain key stressors that shape vulnerability.

### Transportation Insecurity

- Transportation access score is 0.43, ranking in the 76th percentile, indicating limited access.
- Transportation cost burden is moderate (55th percentile).
- Traffic fatalities are zero, reflecting strong safety outcomes.

**Implications:** Transportation access limitations may constrain access to employment, healthcare, and services, particularly for older adults and residents with disabilities. While safety outcomes are strong, limited access underscores the importance of planning emissions reduction strategies that reduce transportation dependence and improve local service access.

### Intersection with Emissions Reduction Planning

- **Energy and Infrastructure Dependence:** Skagway's reliance on delivered fuels, centralized energy systems, and transportation infrastructure means that emissions reduction strategies must be carefully designed to avoid unintended disruptions to essential services.
- **Health Sensitivity and Service Access:** Elevated rates of chronic disease, combined with limited local healthcare capacity, increase community sensitivity to air pollution, extreme weather, and energy system disruptions.
- **Access and Capacity Gaps:** While housing cost burden and income inequality are lower than previously assumed, unemployment, aging demographics, and gaps in education, energy burden, and digital access may affect how evenly sustainability benefits are realized without intentional program design.



## Mitigation Strategies

### Residential Heating Efficiency and Fuel Transition

Residential heating remains the single largest source of emissions in Skagway, driven by residual fuel oil use and an aging housing stock. Improving building envelopes through weatherization, insulation, and air sealing, combined with strategic upgrades to cleaner and more efficient heating systems, offers the greatest opportunity for emissions reduction. Where feasible, transitioning homes to electric heating systems powered by Skagway's predominantly hydro-based grid can significantly reduce direct combustion emissions. This strategy aligns closely with local health and housing conditions. Older homes, higher asthma and cardiovascular disease prevalence, and moderate energy burden all point to the importance of improving indoor environmental quality.

### Community Renewable Energy and Resilient Microgrids

Although Skagway benefits from hydroelectric generation, petroleum-based backup generation still contributes emissions and creates vulnerability during outages and supply disruptions. Community-scale solar paired with battery storage, small wind where appropriate, and targeted microgrids for critical facilities can further reduce fossil fuel reliance while improving system resilience.

These investments are particularly important given Skagway's flood risk, aging population, and limited healthcare access. Ensuring reliable power for clinics, emergency services, and community facilities reduces environmental risk while lowering emissions.

### Transportation Efficiency and Fleet Transition

Transportation emissions in Skagway are dominated by trucks and service vehicles rather than personal vehicles. As a result, the most effective strategies focus on improving efficiency and reducing emissions within existing fleets. This includes anti-idling measures, route optimization, transition to low-carbon fuels such as renewable diesel, and gradual electrification of municipal and service vehicles where infrastructure allows.

Given limited transportation access and an aging population, reducing emissions from existing transportation systems—rather than shifting travel behavior—is both more feasible and more equitable. Cleaner fleets reduce diesel exhaust exposure near residential areas and improve air quality for workers and residents alike, delivering health benefits that are especially important for those with respiratory or cardiovascular conditions.

### Targeted Energy Affordability and Housing Resilience Programs

While overall housing cost burden and income inequality are low to moderate, energy costs remain meaningful, and unemployment and aging demographics increase financial vulnerability for some households. Programs that combine energy efficiency, community solar, and direct energy cost relief can stabilize household expenses while supporting emissions reduction.

By targeting older housing, mobile homes, and households with higher health or mobility needs, these programs can deliver improved outcomes for vulnerable residents without relying on broad, untargeted subsidies. Energy affordability measures also support resilience by reducing the likelihood that households must choose between heating, healthcare, or other essential needs during winter months.





### Improved Outcomes for Overburdened and Underserved Communities

Investments that reduce energy use and improve housing and infrastructure conditions can deliver meaningful improvements in everyday quality of life for residents who experience higher costs, health challenges, or limited access to services. Upgrades such as home weatherization, more efficient heating systems, and improved building performance help stabilize household expenses, reduce exposure to indoor air pollutants, and improve comfort during extreme weather. These improvements are especially important for older adults, residents with chronic health conditions, and those living in older or less efficient housing, where poor indoor conditions can exacerbate physical and mental health stress.

Strengthening local energy and transportation systems also improves reliability and access to essential services. More resilient power systems and efficient transportation reduce disruptions that can isolate residents or limit access to healthcare, employment, and community resources. When paired with workforce development and local capacity building, these investments support stable employment and ensure that improvements are maintained over time. Together, these outcomes help reduce long-standing burdens, increase household stability, and support healthier, safer living conditions across the community.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

#### Residential Heating Efficiency & Fuel Transition

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                  | Community Benefits                                                                                                                         |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Weatherization typically cuts 15–35% heating fuel per home; oil-to-electric conversion (heat pumps/efficient electric) can reduce 50–100% of direct on-site combustion where grid is hydro-dominant; phased boiler upgrades add 5–15%. | Prioritizing homes with highest fuel use and cost burden delivers the largest per-dollar relief and emissions cuts for at-risk households. |
| Energy cost savings | High             | Typical bill savings 20–30% from weatherization; deeper retrofits and fuel switching add further savings (dependent on electric vs. delivered-fuel prices).                                                                            | Direct reduction in energy burden stabilizes finances for at-risk; fewer arrears and energy insecurity.                                    |
| Health benefits     | High             | Less in-home combustion and better ventilation/filtration → lower PM <sub>2.5</sub> /NO <sub>x</sub> ; fewer asthma/COPD triggers; improved thermal comfort.                                                                           | At-risk residents in older or poorly insulated units see outsized gains in IAQ, comfort, and stress reduction.                             |
| Resilience          | High             | Tight envelopes maintain habitable temps longer during outages (often +12–24 hours vs. baseline); diversified heating options reduce fuel-delivery exposure.                                                                           | Homes most at risk during cold snaps gain the most from outage ride-through and safer indoor temps.                                        |
| Disbenefits / risks | Low–Moderate     | Upfront costs; contractor capacity; cold-climate heat pump performance requires proper design; over-tightening without balanced ventilation.                                                                                           | If program design requires co-pays or credit checks, resident uptake may lag—ensure no-cost options and ventilation standards.             |

### Community Renewable Energy & Resilient Microgrids (solar + storage, small wind, waste-heat, district energy)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                  | Community Benefits                                                                                                                      |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Storage-backed renewables can displace 70–90% of diesel kWh at sites with adequate resources; waste-heat/district systems can offset 10–30% of community heating load. | Targeting critical facilities and at-risk neighborhoods concentrates both emissions cuts and local air-quality gains where most needed. |
| Energy cost savings | Moderate–High    | Avoided diesel + logistics; community solar can deliver 5–20% bill credits; district energy lowers delivered-fuel purchases.                                           | Bill credits and stable tariffs directly lower energy burdens; design inclusive enrollment by default.                                  |
| Health benefits     | Moderate–High    | Reduced generator runtime → less local PM/NO <sub>x</sub> ; district heat moves combustion away from homes and improves IAQ.                                           | Cleaner air and steadier heat benefit at-risk residents who may live closer to generators or along delivery routes.                     |
| Resilience          | High             | Microgrids keep clinics/shelters/schools powered during outages; less dependence on weather-sensitive fuel deliveries.                                                 | Critical for residents with fewer backup options; protects access to heat, refrigeration, and communications.                           |
| Disbenefits / risks | Low–Moderate     | Intermittency if storage is undersized; O&M in remote conditions; tariff design must avoid cost shifts to non-participants.                                            | Ensure default participation and bill protections to prevent unintended rate impacts                                                    |



**Transportation Efficiency & Fleet Transition (logistics, low-carbon fuels, EVs where feasible)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                | Community Benefits                                                                                                            |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Light-duty EVs: ~50–70% WTW reductions on a hydro-dominant grid; anti-idling/routing: 5–10% fuel cuts for heavy duty; renewable diesel/biodiesel blends can deliver ~20–60% lifecycle reductions (supply-dependent). | Cleaner corridors near homes/workplaces reduce exposure for at-risk residents and workers using shared shuttles.              |
| Energy cost savings | Moderate         | EVs offer lower fuel/maintenance TCO; anti-idling saves fuel; low-carbon fuels vary from cost-neutral to premium.                                                                                                    | Lower operating costs can stabilize fares/shuttle access; savings should be reinvested in routes serving at-risk populations. |
| Health benefits     | Moderate         | Less diesel exhaust at loading areas and along routes; fewer cold-start and idle events.                                                                                                                             | At-risk workers and households near busy roads gain direct exposure reductions.                                               |
| Resilience          | Moderate         | Diversifies fuels; depot charging tied to microgrids mitigates fuel-delivery disruptions.                                                                                                                            | More reliable mobility for essential workers during supply interruptions benefits those with few transport alternatives.      |
| Disbenefits / risks | Low–Moderate     | Cold-weather range limits; charging build-out; renewable diesel supply variability; need for driver/tech training.                                                                                                   | Ensure shared fleet access and cold-weather specs to serve reliably.                                                          |

**Cross-Cutting Community Benefits and Disbenefits**

Across all strategies, benefits for community benefits include:

- Lower household energy costs from weatherization, fuel switching, and community solar → more affordable living.
- Cleaner indoor and outdoor air from reduced fuel oil and diesel use → better respiratory and cardiovascular health.
- More reliable and resilient energy systems (microgrids, storage, efficiency) → fewer disruptions during cold weather or outages.
- Increased housing comfort and safety → reduced stress, better mental health, and protection for vulnerable populations.
- Local workforce training and hiring → stable employment opportunities and new economic pathways.
- Expanded digital access tied to infrastructure upgrades → improved telehealth, education, and job participation.

Potential disbenefits if not designed equitably:

- Upfront capital costs of efficiency or renewable systems → risk of excluding at-risk households if subsidies are not provided.
- Poor tariff or program design → possibility of cost-shifting to non-participants or higher rates for those left out.
- Limited contractor or workforce capacity → slower delivery of benefits, particularly to remote or vulnerable households.

## Path Forward

The next phase of action for Skagway should focus on advancing a small number of priority measures that address the community's largest sources of emissions while strengthening reliability and day-to-day conditions for residents. Early efforts should concentrate on improving residential heating efficiency, reducing reliance on delivered fuels, and expanding resilient, low-emissions energy systems for homes and critical facilities. These actions offer the greatest potential for near-term impact and provide a strong foundation for longer-term progress.

Implementation should emphasize targeted, practical programs that reflect local capacity and housing conditions. Prioritizing older homes, mobile housing, and residents with greater health or mobility needs will help ensure that investments reach those who benefit most from improved comfort, safety, and cost stability. Coordinating energy improvements with flood resilience, building upgrades, and infrastructure maintenance can further strengthen outcomes and reduce long-term risk.

Sustained progress will also depend on building local capacity to deliver and maintain these improvements. Workforce training, partnerships with regional providers, and clear program design will support efficient implementation and reduce reliance on outside contractors. By sequencing actions thoughtfully and aligning them with community needs and resources, Skagway can move forward with a practical, resilient approach that delivers lasting benefits while steadily reducing emissions.





# Bering Straits, Nome Census Area



Population: 6,058

Census Tract: 2180000100

Communities: Brevig Mission, Diomedea, Elim, Gambell, Golovin, Koyuk, Port Clarence, Saint Michael, Savoonga, Shaktoolik, Shishmaref, Stebbins, Teller, Unalakleet, Wales, White Mountain

The within the Bering Straits region, within the Nome Census Area, faces a unique convergence of challenges and opportunities in addressing emissions. The region's emissions profile is dominated by stationary fuel use for heating and electricity, along with heavy-duty transportation, reflecting its reliance on imported petroleum products. At the same time, the community experiences some of the highest energy and transportation cost burdens in the nation, with poverty, unemployment, and housing quality issues compounding vulnerability.

These interconnected challenges present an opportunity to improve regional stability, health, and self-sufficiency through targeted emission-reduction efforts. By focusing on energy efficiency, renewable generation, and transportation modernization, communities can reduce operating costs, strengthen infrastructure reliability, and create local jobs. The following analysis highlights three strategies that offer the strongest combined benefits for reducing emissions while improving living conditions, public health, and long-term resilience in the Bering Straits region.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Home Energy Retrofits and Fuel Transition
2. Community-scale renewable generation with storage
3. Transportation Fleet Transition (Public and Heavy-Duty Vehicles)

Together, these three strategies address the largest emission sources (stationary fuel use and heavy transport) while delivering direct cost relief, health improvements, and resilience gains for vulnerable and Alaska Native communities.

## Emissions Data Overview

Note that these data contain emissions for the entire Nome Census Area, which consists of two Census Tracts.

Total Modeled Emissions: 85,131 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (66.65%)

- Residential: 44.20 % of the total
  - Electricity: 4,834 mt (5.68%)
  - Propane: 24 mt (0.03%)
  - Residual Fuel Oil No. 5: 32,721 mt (38.44%)
  - Wood: 51 mt (0.06%)
- Commercial: 22.45 % of the total
  - Distillate Fuel Oil No. 1: 8,892 mt (10.44%)
  - Propane: 679 mt (0.8%)
  - Wood: 25 mt (0.03%)
  - Electricity: 9,517 mt (11.18%)
- Industrial: 0 %

Residual fuel oil dominates residential emissions, while commercial relies mainly on distillate fuel oil and electricity. Wood and propane are negligible.

### Transportation (33.35%)

- Fuel types:
  - Diesel: 5,618 mt
  - Gasoline: 22,772 mt
- Vehicle classes:
  - Trucks: 27,288 mt (~96% of transport emissions)
  - Motorcycles: 39 mt
  - Passenger vehicles: 1,063 mt

Trucks dominate transportation emissions, gasoline is the leading fuel, and passenger vehicles play a relatively small role.

### Electricity Generation

- Electricity usage: 51,371 MWh total
  - Wind: 1,027 MWh → 0 mt emissions
  - Petroleum-based generation: 49,830 MWh → 14,351 mt emissions

Electricity is overwhelmingly petroleum-based; wind contributes very little.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Solid waste and wastewater emissions were not included in this dataset.

### Key Takeaways

- Stationary combustion is the largest emissions source, driven by residential fuel oil.
- Transportation is the second major sector, with trucks and gasoline as the main contributors.
- Electricity generation adds a significant emissions load, nearly all from petroleum.

## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather:** Anticipated changes in extreme weather index is 9.66, signaling higher vulnerability to environmental disruptions.
- **Disaster Loss:** Annualized disaster loss percentile is 14.77, relatively low compared to the nation, though dollar impact (\$244,743) reflects localized risk.
- **Air & Hazardous Exposures:** Diesel particulate exposure, toxic releases, hazardous site proximity, and superfund proximity are all 0.00, suggesting low industrial pollution exposure.
- **Former Defense Sites:** Presence of Formerly Used Defense Sites (FUDS) may signal legacy contamination concerns.
- **Housing Stock:** 44.48% of homes are pre-1980s, placing them in the 67th national percentile for older housing stock, which may include poor insulation, lead paint, or asbestos.
- **Transportation Hazards:** Road and airport proximities are minimal, though airport proximity (1.13%) may contribute some air quality or noise issues.

Implications: While current environmental burdens appear low compared to national averages, the combination of older housing, exposure to severe weather, and legacy defense sites suggests long-term risks that may intensify as environmental conditions become more variable and extreme.

### Public Health Indicators

- **Asthma & Cancer Prevalence:** Rates are 3.23% and 1.10%, both below national medians, indicating fewer respiratory and cancer burdens from pollution sources.
- **Chronic Conditions:** High blood pressure (8.98%) and diabetes (3.48%) are moderate, but heart disease prevalence is extremely high (90th percentile nationally).
- **Mental Health:** Poor mental health prevalence is 4.75%, around the 32nd percentile, showing moderate concern.
- **Life Expectancy:** Average life expectancy is 84.7 years, far above U.S. averages.

Implications: Despite elevated heart disease, overall life expectancy and general health indicators suggest resilience; however, environmental stressors that increase cardiovascular risk or mental health strain could disproportionately impact this population.

### Socioeconomic Factors

- **Poverty:** A striking 63.67% live below 200% of the federal poverty line (98th percentile nationally).
- **Education & Employment:** 19.7% have no high school diploma (98th percentile) and unemployment is 14.2% (also 98th percentile).
- **Housing & Insurance:** Median home value is only \$88,100, but cost burden is relatively modest (20.33%). However, 20.5% are uninsured (87th percentile nationally).
- **Digital Divide:** 29.9% lack internet access (90th percentile).
- **Energy Burden:** Extremely high at 9% of income, ranking in the 99th national percentile.
- **Demographics:** Youth population is disproportionately high (38% under 17, 97th percentile), while only 8% are 65+. Disability prevalence is 10.7%, and 3% have limited English proficiency.

Implications: The socioeconomic profile points to systemic inequities: widespread poverty, low educational attainment, and extreme energy burden limit adaptive capacity, while a high youth population suggests intergenerational vulnerability to environmental impacts.

### Transportation Insecurity

- Access: Transportation access score is 0.04, close to average (45th percentile nationally).
- Cost Burden: Transportation costs consume 21% of household income, among the highest in the nation (95th percentile).
- Safety: Fatalities are 12.74 per 100,000, at the 97th national percentile, highlighting serious safety concerns.

Implications: While access is comparable to the national average, high cost and dangerous conditions amplify socioeconomic challenges, limiting mobility and resilience under environmental disruption.

### Intersection with Emissions Reduction Planning

- Energy burden and poverty mean households already face disproportionate economic strain. Transitioning to low-carbon solutions will need to emphasize affordability, subsidies, and efficiency upgrades.
- Health vulnerabilities, especially heart disease, may be aggravated by pollution or environmental stress, making health co-benefits a vital framing.
- Youth-heavy demographics highlight the importance of long-term planning, as future generations will bear the greatest burden of extreme weather events.
- Digital and transportation inequities may hinder community engagement, access to new technologies, and adoption of clean-energy or mobility solutions unless equity-focused approaches are prioritized.
- Environmental baselines suggest relatively low current industrial pollution but high environmental vulnerability, meaning adaptation and resilience will be equally as important as mitigation.



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## Mitigation Strategies

### Energy Transition and Efficiency

Given the extremely high energy burden (99th percentile nationally) and the heavy reliance on residual and distillate fuel oils for heating and electricity, transitioning energy systems is both a health and equity issue. Expanding community-scale renewable energy (e.g., wind, solar with storage) can reduce dependence on imported petroleum while stabilizing household costs. Pairing this with weatherization and housing retrofits—especially targeting the large share of pre-1980s homes—would cut emissions and lower heating bills. Efficiency upgrades should prioritize insulation, window replacement, and electrification of heating systems. Workforce development for local retrofitting jobs could further alleviate unemployment while building community resilience.

### Transportation Modernization

Transportation emissions represent one-third of the region's total, with trucks as the dominant contributor. At the same time, transportation costs consume a disproportionate share of household income (95th percentile nationally) and traffic fatalities are very high. Strategies could include fleet transition programs for heavy-duty vehicles, replacing diesel trucks with electric or hybrid alternatives where feasible, supported by localized charging infrastructure. For passenger mobility, investments in shared transport services, improved safety infrastructure, and subsidies for efficient vehicles would ease the dual burden of high costs and poor safety outcomes. Partnerships with shipping and aviation services are also critical, as these lifelines could adopt lower-emission fuels that reduce both costs and air pollution.

### Health and Community Resilience Co-Benefits

Health data highlights high cardiovascular disease prevalence despite a high overall life expectancy. Environmental stressors, cold weather, and energy insecurity intensify these risks. Integrating mitigation with public health co-benefits is essential: for example, improved air quality from reducing petroleum combustion will directly benefit heart and lung health. Coupling home energy retrofits with indoor air quality improvements (ventilation, mold remediation) will enhance health resilience. Community programs can also address mental health strain tied to environmental disruption and economic stress. Aligning health services with sustainability actions will ensure that transitions reduce—not exacerbate—existing disparities.

### Improved Outcomes for Overburdened and Underserved Communities

The Bering Straits region is home to many vulnerable, and Alaska Native communities that face high poverty, unemployment, uninsured rates, and some of the highest energy burdens in the nation. By centering mitigation strategies on these realities, emissions reduction actions can deliver meaningful benefits beyond emissions reductions.

Energy transition and housing retrofits will directly reduce the cost of living for households already stretched by heating and power bills. Warmer, more efficient homes not only lower monthly expenses but also improve indoor air quality, reducing risks for cardiovascular and respiratory disease. Similarly, shifting away from petroleum fuels improves outdoor air quality, strengthening health equity and reducing chronic disease burdens.

Transportation modernization will also enhance outcomes by lowering the region's very high mobility costs and addressing safety risks. Cleaner, more reliable vehicles and shared transport options will improve access to jobs, schools, and healthcare for remote households. At the same time, the region's unusually young population will benefit from new workforce pathways in renewable energy, housing retrofits, and sustainable land use, creating long-term economic resilience rooted in community priorities.

Finally, equity-centered governance—grounded in tribal leadership and community ownership—ensures that at-risk households have a voice in shaping the energy transition. This not only secures fair access to benefits but also reinforces cultural integrity and trust, making emissions reduction strategies more durable and effective over time.

**Benefit (Disbenefit) Quantification or Qualitative Analysis****Residential and Community Energy Transition**

Energy Transition &amp; Efficiency (weatherization, building electrification, local renewables)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                                                                                                                                          | Community Benefits                                                                                                                             |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Targeting stationary fuels first (largest source). If 25–35% of homes receive ~20–30% fuel-use cuts from weatherization/electrification, that yields ~5,000–10,000 mt CO <sub>2</sub> e/yr from residential alone; add 10–20% savings across priority public/commercial buildings → another 2,000–4,000 mt/yr. Early community renewables (wind/solar + storage) can displace part of petroleum gen (order 1,000–3,000 mt/yr). | Maximizes benefits where energy burden is extreme; lowers reliance on delivered fuels in rural/remote communities; durable reductions.         |
| Energy cost savings | High             | Typical household heating fuel savings 20–35% after weatherization; electrification/heat pumps can add more where electricity is affordable/available. Directionally \$800–\$2,000/household-yr (wide local range). Public/commercial retrofits trim operating budgets.                                                                                                                                                        | Direct relief for low-income households (very high energy burden); stabilizes bills; reduces fuel debt risk.                                   |
| Health benefits     | High             | Better envelopes + ventilation reduce damp/mold and indoor combustion exposure; outdoor air improves as local oil use falls. Co-benefits salient given elevated cardiovascular burden.                                                                                                                                                                                                                                         | Disproportionate gains for homes with children, elders, and those with chronic disease; fewer missed work/school days.                         |
| Resilience          | High             | Cuts dependence on fuel shipments; improves winter survivability (warmer homes at lower cost); microgrid renewables + storage provide outage ride-through for critical facilities.                                                                                                                                                                                                                                             | Reduces vulnerability for remote and vulnerable villages during weather/freight disruptions; supports community facilities (clinics, schools). |
| Disbenefits / risks | Moderate         | Up-front capital; contractor capacity; cold-climate heat pump performance needs right design; electricity price/exposure if power is petroleum-based; maintenance gaps.                                                                                                                                                                                                                                                        | Avoid cost-shift: pair with grants/rebates, no-cost audits, community workforce training; prioritize safety/IAQ retrofits first.               |

### Transportation Modernization (fleet efficiency, targeted electrification, safety & access)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                         | Community Benefits                                                                                                                                                |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Transport $\approx$ 28.4k mt/yr. If 10–20% of VMT shifts to higher-efficiency/ EV over near term, directional cut 1,500–4,000 mt/yr (heavier duty trucks dominate emissions; feasible early wins in public fleets, school buses, light-duty). | Benefits accrue where trucks serve essential goods; prioritize public/ tribal fleets, school buses, and high-use service vehicles that serve at-risk communities. |
| Energy cost savings | Moderate         | Fuel + maintenance savings for LD EVs often \$400–\$1,500/vehicle-yr in rural contexts (shorter driving, cold-weather penalties). Efficient tires/ driver training for trucks can cut fuel 5–10%; routing/logistics gains add more.           | Lower travel costs improve access to jobs, food, health care; savings meaningful for cost-burdened households and small operators.                                |
| Health benefits     | Moderate         | Less tailpipe pollution along key corridors; quieter streets; safety upgrades (lighting, crossings, speed mgmt) reduce injuries in a region with high fatality rates.                                                                         | Air-quality and safety gains accrue in town centers and village roads used by at-risk residents; cleaner school transport protects kids.                          |
| Resilience          | Moderate         | Reduced exposure to volatile fuel prices; local charging at hubs; anti-idling + pre-heat electrification improve winter reliability.                                                                                                          | More dependable access for medical trips and freight; supports emergency mobility in outages if paired with microgrid charging.                                   |
| Disbenefits / risks | Moderate         | Cold-weather range loss; sparse charging; high upfront costs for EVs/ ZE trucks; maritime/aviation not directly addressed; grid readiness at depots.                                                                                          | Mitigate with subsidies for at-risk users/fleets, depot-first charging, reliability standards, and right-sizing (PHEV/efficiency where BEV isn't practical yet).  |



**Health & Community Resilience Co-Benefits (IAQ, clinic & shelter upgrades, stress reduction)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                       | Community Benefits                                                                                                        |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate     | Not a primary driver; indirect reductions via better IAQ standards that discourage indoor combustion, plus efficiency in clinics/shelters (hundreds to low thousands mt/yr potential when bundled with facility retrofits). | Indirect—but aligns health investments with decarbonization in facilities serving low-income and Alaska Native residents. |
| Energy cost savings | Moderate         | Health-facility retrofits (envelope, controls, heat recovery) cut utility spend 10–25%; community shelter/weatherization lowers emergency operating costs.                                                                  | Savings protect essential services in under-resourced places; frees local funds for care, food, housing support.          |
| Health benefits     | High             | IAQ upgrades + weatherization reduce respiratory/cardiovascular triggers; warm, dry homes improve mental health; clinic reliability (backup + storage) ensures continuity of care.                                          | Outsized benefits for children, elders, and those with chronic disease; advances equity by closing outcome gaps.          |
| Resilience          | High             | Critical facilities (clinics, water/wastewater, shelters) gain backup power and thermal stability; community spaces can serve as clean-air/warm centers during outages or smoke events.                                     | Reduces disaster mortality/morbidity risk for remote at-risk communities; improves trust in local systems.                |
| Disbenefits / risks | Low–Moderate     | O&M capacity for advanced HVAC/filtration; need culturally appropriate engagement; risk of project fragmentation without coordination.                                                                                      | Address with local training, simple/maintainable tech, and tribal/municipal leadership in design & phasing.               |



By Lane Schwartz, wikimedia



### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household costs: Reduced spending on heating, electricity, and fuel directly addresses the region's very high energy and transportation cost burdens.
- Improved health equity: Better air quality, warmer homes, and safer transport reduce cardiovascular disease, respiratory issues, and injury risks.
- Increased resilience: Enhanced energy reliability and safer mobility systems reduce vulnerability during extreme weather, outages, or supply disruptions.
- Youth and workforce opportunity: Training and local jobs in clean energy, weatherization, and transport modernization create long-term economic pathways for a youth-heavy population.
- Community empowerment: Tribal leadership and community-led projects ensure strategies align with cultural priorities and protect subsistence practices.

Potential disbenefits if not designed equitably:

- High upfront costs: Without subsidies or grants, low-income households may be excluded from upgrades or bear disproportionate financial risks.
- Infrastructure gaps: Limited contractor base, sparse charging infrastructure, and challenging logistics could delay or unevenly distribute benefits.
- Technology performance issues: Cold climate impacts on electric systems (heat pumps, EVs) may reduce effectiveness if not properly designed.
- Equity risks in rollout: If programs rely too heavily on digital access or cost-sharing, they may leave behind households with no internet, limited English proficiency, or high poverty.
- Maintenance and capacity needs: Advanced systems (HVAC, renewables, EV fleets) require local skills and consistent upkeep; without training and resources, benefits may erode over time.

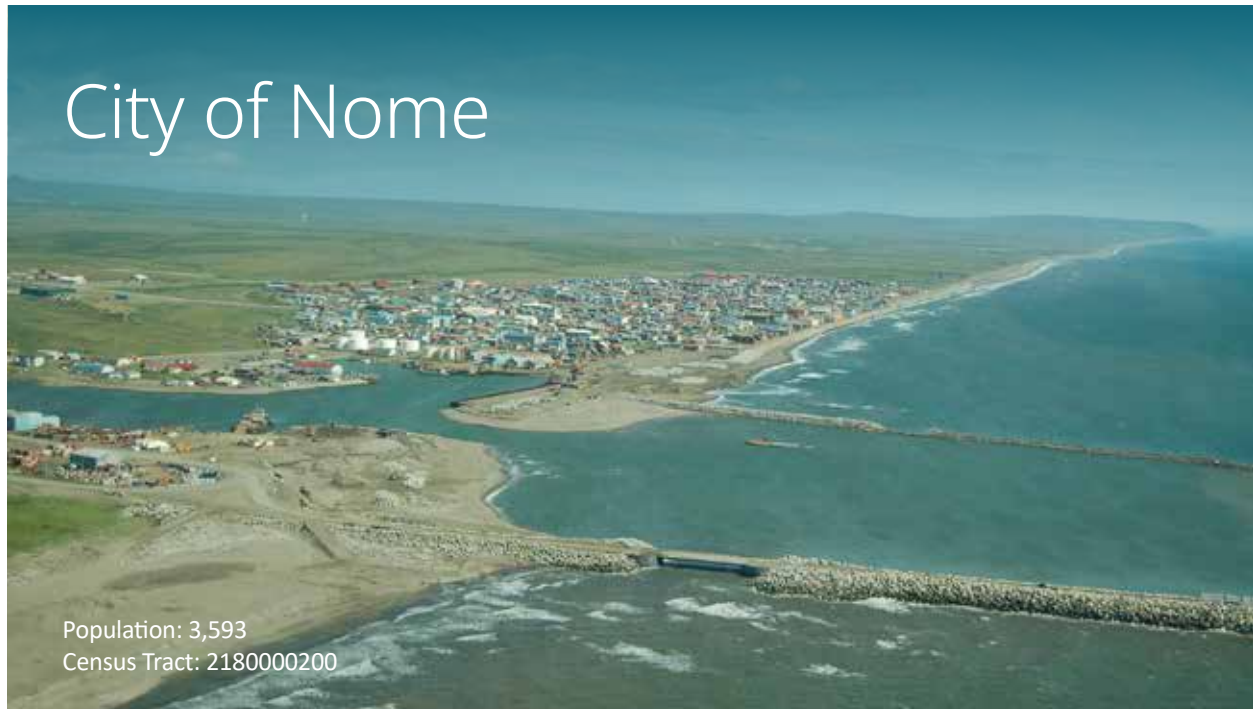
### Path Forward

The Bering Strait region's priorities—energy reliability, affordability, and local opportunity—are closely linked to its emissions profile. Because home heating, electricity, and transportation drive most of the area's fuel use, practical solutions lie in improving efficiency, developing local energy resources, and upgrading essential systems.

Home energy retrofits, community-based renewable projects, and modernized vehicle fleets together form a balanced pathway for progress. These strategies can significantly cut fuel use, reduce house-hold costs, and improve air quality, while also strengthening local capacity and technical skills. Early investment in these areas can produce measurable economic and health benefits, particularly for households that currently face high costs and limited options.

Moving forward, success will depend on coordinated action—combining community leadership, state and regional support, and sustained investment in infrastructure and workforce development. By focusing on practical energy improvements and equitable access to resources, the region can enhance its self-reliance, safeguard public well-being, and ensure a stronger, more secure future for its communities.





Nome, Alaska faces a unique intersection of environmental, health, and socioeconomic challenges that shape both community well-being and sustainability policy opportunities. As a remote hub in western Alaska with a population of just under 3,600, the region is heavily dependent on imported fuels for heating, transportation, and electricity generation—dependencies that create both high costs and significant emissions. These conditions are compounded by geographic isolation, aging infrastructure, and limited local energy alternatives, leaving many households vulnerable to energy price volatility and supply disruptions.

The community's health and socioeconomic indicators reveal important disparities. Elevated rates of asthma, diabetes, and poor mental health intersect with high unemployment, housing cost burdens, and a large proportion of rental housing. Many homes are older and inefficient, contributing to both health and affordability challenges. Together, these factors underscore the need for a transition that not only reduces emissions but also improves local living conditions, supports economic stability, and advances equity in access to energy and opportunity.

This roadmap draws on available data to describe the social and environmental context of Nome and identify the most effective strategies for reducing emissions. The approach emphasizes solutions that deliver multiple community benefits—lower costs, improved health, and greater local control over essential systems—creating a stronger foundation for long-term sustainability.

### Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Transitioning Residential Heating Away from Fuel Oil
2. Expanding Local Renewable Energy and Storage
3. Workforce Development in Clean Energy and Building Retrofits

By targeting residential heating transition, renewable energy expansion, and workforce development, Nome can reduce its largest emission sources while also addressing high energy burdens, poor health outcomes, and socioeconomic inequities. These strategies maximize co-benefits for at-risk populations, making them the most impactful priorities for both emissions reduction and community well-being.

## Emissions Data Overview

Total Modeled Emissions: 39,417 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (66.41%)

- Residential sector (44.87 % of total emissions)
  - Residual Fuel Oil No. 5: 15,324.28 mt CO<sub>2</sub>e (38.88 % of total emissions)
  - Electricity: 2,320.07 mt CO<sub>2</sub>e (5.89 %)
  - Propane: 23.81 mt CO<sub>2</sub>e (0.06 %)
  - Wood and wood residuals: 16.39 mt CO<sub>2</sub>e (0.04 %)
- Commercial sector (23.55 % of total emissions)
  - Distillate Fuel Oil No. 1: 3,390.72 mt CO<sub>2</sub>e (8.60 %)
  - Electricity: 5,622.97 mt CO<sub>2</sub>e (14.27 %)
  - Propane: 258.85 mt CO<sub>2</sub>e (0.66 %)
  - Wood and wood residuals: 9.41 mt CO<sub>2</sub>e (0.02 %)
- Industrial: 0 %

### Transportation (31.59%)

- By fuel type
  - Motor Gasoline: 9,986.42 mt CO<sub>2</sub>e (25.34 % of total emissions)
  - Diesel Fuel: 2,463.61 mt CO<sub>2</sub>e (6.25 %)
- By vehicle type
  - Trucks: 11,966.88 mt CO<sub>2</sub>e (96.12 % of transportation emissions)
  - Passenger vehicles: 466.10 mt CO<sub>2</sub>e (3.74 %)
  - Motorcycles: 17.04 mt CO<sub>2</sub>e (0.14 %)

### Electricity Generation

- Total electricity usage: 29,655.90 MWh
- Fuel breakdown
  - Diesel: 7,943.04 mt CO<sub>2</sub>e — from 27,579.98 MWh generated
  - Wind: 1,779.35 MWh — 0 mt CO<sub>2</sub>e (non-emitting)

Note: Wind contributes to the energy mix but produces no emissions; essentially, all emissions from electricity come from diesel generation.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Solid waste and wastewater emissions were not included in this dataset.

### Key Takeaways

- Heavy reliance on oil fuels: Nearly 70% of emissions come from stationary combustion, especially heating with residual fuel oil in homes and distillate fuel oil in businesses. This reflects dependence on imported fossil fuels for heat.
- Transportation is secondary but significant: About one-third of emissions come from transportation, with trucks accounting for almost all of it. Gasoline use dominates, followed by diesel.
- Electricity is mostly diesel-powered: Although Nome has some wind capacity, virtually all emissions from electricity come from diesel generation. Wind offsets some electricity demand but contributes zero emissions.
- Residential heating dominates: Heating oil in homes is the single largest emissions source, making residential buildings the central driver of Nome's carbon footprint.
- Commercial sector adds a major share: Businesses contribute heavily through both fuel oil use and electricity consumption, underscoring the importance of non-residential building efficiency.

Nome's emissions are concentrated in three key areas—residential heating, commercial fuel/electricity use, and truck transportation—all of which are tied directly to fossil fuel dependence. This concentration means targeted improvements in building energy efficiency, heating systems, renewable integration, and vehicle fuel use could have an outsized impact.

## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather & Disaster Loss:** Nome shows a modest level of anticipated extreme weather change (0.57) but registers a notable disaster loss percentile (15.34), representing nearly \$263,500 annually.
- **Pollution & Exposure:** Diesel particulate matter (0.00) and toxic releases (0.00) indicate negligible air quality risks, though there is an elevated cancer risk index (9.00).
- **Hazardous Sites:** No active hazardous sites, waste, or superfund proximity are reported, though Nome contains a Formerly Used Defense Site, suggesting potential legacy contamination concerns.
- **Housing Stock:** About 39% of housing is pre-1980s, with a national percentile rank of 56.25, raising issues of aging infrastructure.
- **Flood Risk:** 9% of properties are at flood risk, a percentile rank of 59.00, placing Nome above the national midpoint in vulnerability.
- **Airport Proximity:** At 4.1%, airport adjacency may present localized air quality or noise issues, though percentile risk is moderate (24.43).

Implications: Nome has relatively low direct industrial pollution risks but faces significant environmental risks from flooding and legacy contamination. The age of housing stock may exacerbate vulnerability to weather and energy efficiency challenges.

### Public Health Indicators

- **Asthma Prevalence:** 10.2% of the population, ranking extremely high nationally (96.59 percentile).
- **Mental Health:** Poor mental health prevalence is 14.1%, one of the highest nationally (97.73 percentile).
- **Chronic Conditions:** High blood pressure (28.4%) and diabetes (8.1%) are also elevated nationally (82.10 and 88.64 percentiles, respectively).
- **Life Expectancy:** At 79.7 years, slightly above national averages, but percentile rank is moderate (37.00).
- **Cancer Prevalence:** 4.8% of population, ranking at the 79.26 percentile.

Implications: Nome experiences significant chronic disease and mental health burdens. Elevated asthma rates, combined with older housing and environmental vulnerabilities, suggest that environmental and health risks are interconnected and may worsen under environmental changes.

### Socioeconomic Factors

- **Poverty & Employment:** 16.41% live below 200% of the poverty line; unemployment is 8.5% (very high at 89.20 percentile).
- **Education:** 7.3% without a high school diploma, higher than many regions (63.07 percentile).
- **Housing:** Nearly half (49.93%) of units are renter-occupied (79.55 percentile), and 26.05% face housing cost burdens. Median home value is \$252,200 (63.00 percentile).
- **Insurance & Access:** 16.9% are uninsured (73.58 percentile), and 12.9% lack internet access (54.26 percentile).
- **Demographics:** A youthful population with 29.6% under 17 (82.39 percentile) and a smaller elder population (7.47% at 88.64 percentile). Disability rates are relatively low (6.6%).
- **Energy Burden:** At 4% of income, Nome sits high nationally (81.00 percentile), indicating disproportionate energy costs.

Implications: Nome's high unemployment, housing insecurity, and elevated energy burdens place stress on families and reduce financial flexibility for adaptation measures. Youth demographics may amplify future workforce and equity considerations.



### Transportation Insecurity

- **Access & Costs:** Transportation access is below average (-0.39, 30.95 percentile) and cost burdens are low (0.11%, 27.75 percentile).
- **Safety:** Traffic fatalities stand at 3.28 per 100,000, with a higher-than-average national percentile (70.45).

Implications: Nome faces some transportation access challenges, though financial cost is not a major barrier. Safety issues remain a concern, and geographic remoteness intensifies reliance on limited infrastructure.

### Intersection with Emissions Reduction Planning

The social determinants outlined above reveal how Nome's community conditions intersect with future emissions reduction efforts:

- **Health Risks & Environmental Stress:** Elevated asthma and mental health burdens mean residents may be especially sensitive to worsening air quality, indoor air conditions in older housing, and stressors from environmental impacts.
- **Energy Burden & Housing Stock:** High energy costs and aging homes highlight the importance of energy efficiency improvements that reduce pollution while easing financial strain.
- **Socioeconomic Vulnerability:** High unemployment and housing insecurity limit adaptive capacity. Any sustainability strategy must integrate equity, affordability, and community stability.
- **Environmental Hazards:** Flood risk and legacy contamination sites increase the urgency of resilient infrastructure investment that simultaneously reduces emissions and protects public health.
- **Demographics:** A young population may benefit from long-term emissions reduction planning, workforce development in clean energy, and educational pathways aligned with pollution reduction goals.

Overall Implication: Nome's health burdens, economic vulnerabilities, and environmental risks suggest that emissions reduction strategies must be framed not only as emissions goals but also as tools to reduce inequities, lower costs, and improve health outcomes.

## Mitigation Strategies

### Building Energy Efficiency and Heating Transition

Residential heating is the largest single contributor to emissions in Nome, largely from residual fuel oil. This dependence also drives high energy burdens, which already sit above the national average. With nearly 40% of homes built before 1980, there is significant opportunity to reduce fuel use through targeted retrofits. Strategies should include large-scale weatherization programs that improve insulation and air sealing in aging homes, paired with incentives for upgrading to efficient heating systems such as air-source or ground-source heat pumps designed for Arctic climates. For renters, who make up half of the housing stock, landlord-focused retrofit support and tenant protections will be essential to ensure improvements do not worsen housing cost burdens. Building code updates for any new construction should emphasize energy efficiency and renewable-ready design. Collectively, these efforts would not only cut emissions but also alleviate household energy costs, reduce asthma triggers in older housing, and improve community resilience to extreme cold.

### Renewable and Resilient Energy Systems

Nome's electricity generation is overwhelmingly reliant on diesel, with wind supplying only a small share of power. Expanding local renewable energy—particularly wind, solar with battery storage, and potentially tidal or hydrokinetic options—could displace diesel generation while enhancing resilience during supply disruptions. Investment in microgrids and community-scale energy storage would stabilize variable renewables, while district heating systems could harness waste heat from generators or renewable thermal sources to provide low-emission community-wide heating. Transitioning municipal and school facilities to renewable-powered microgrids could serve as pilot projects, demonstrating

feasibility and reducing operational costs. These investments directly address the high energy burden, provide local energy sovereignty, and reduce the pollution exposure that worsens chronic health conditions.

### **Sustainable Transportation and Mobility**

Transportation is the second-largest source of emissions in Nome, dominated by truck traffic fueled by gasoline and diesel. While the community's geographic isolation and limited road network constrain options, electrification of municipal fleets, school buses, and essential service vehicles represents a practical starting point. Expanded support for electric vehicle charging infrastructure, coupled with financial incentives or cooperative purchasing programs, could encourage gradual adoption of EVs in households and businesses. At the same time, strengthening local transit options, ride-sharing initiatives, and active mobility infrastructure (e.g., safe pedestrian routes, winterized bike paths) could reduce dependence on individual vehicles. Safety interventions, given Nome's high traffic fatality rate, would further align transportation strategies with public health benefits.

### **Workforce Development**

Socioeconomic conditions in Nome—high unemployment, renter occupancy, and a youthful demographic profile—highlight the importance of pairing sustainability action with economic opportunity. Workforce development programs that train young residents in renewable energy installation, building retrofits, and EV maintenance could create stable local jobs while ensuring that clean energy investments circulate within the community. Policies that prioritize equitable access, such as subsidizing clean energy upgrades for low-income households and ensuring renters benefit from improvements, will be critical. This equity-first approach reduces disparities, fosters community buy-in, and ensures that the transition to a low-carbon future also strengthens economic resilience.

### **Improved Outcomes for Overburdened and Underserved Communities**

Improved outcomes for Nome's at-risk populations will emerge when emissions reduction strategies are intentionally designed to address the community's existing vulnerabilities. Energy efficiency upgrades in older homes, for example, will not only lower reliance on costly fuel oil but also reduce exposure to indoor air pollutants that contribute to Nome's extremely high asthma prevalence. For households already experiencing high energy burdens, weatherization and modernized heating will free up household income for food, health care, and other essentials—directly improving quality of life while strengthening resilience against extreme cold.

Investments in renewable energy and microgrids will also create measurable benefits for vulnerable households. By reducing diesel dependence, the community can stabilize energy costs that are currently volatile due to supply chain constraints. Greater reliability in electricity and heating systems reduces the likelihood of outages during extreme weather events, which disproportionately affect elders, children, and households with limited resources. For Indigenous communities in particular, decentralized and locally managed energy systems reinforce autonomy and self-determination in shaping a sustainable future.

Finally, workforce development initiatives tied to building retrofits, renewable installations, and transportation electrification will ensure that young residents in Nome—nearly one-third of whom are under 17—see real pathways into stable, future-oriented employment. These programs can be designed to align with traditional knowledge and community priorities, creating opportunities that honor cultural values while preparing the next generation for leadership in the clean energy transition. In this way, emissions reduction planning becomes not only a tool for emissions mitigation, but also a driver of economic empowerment, health equity, and long-term community resilience for Nome's most vulnerable residents.

**Benefit (Disbenefit) Quantification or Qualitative Analysis****Residential Heating Transition (fuel oil → weatherization + cold-climate heat pumps; with tenant protections)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                                                                                    | Community Benefits                                                                                                                                                       |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Residential heating is the largest source ( $\approx 45\%$ of total; $\approx 15,300$ mt CO <sub>2</sub> e from fuel oil alone). Near-term: 20–40% cut in residential heating emissions with heat pumps on current grid (efficiency gain even on diesel power). With cleaner grid: 60–80% cut in residential heating emissions. Program scale determines realized share. | Strong co-benefits if upgrades prioritize at-risk households first; reduces community exposure to fossil fuels; supports energy sovereignty when paired with renewables. |
| Energy cost savings | High             | Deep weatherization (shell + controls) can reduce heating load 20–40%+. Heat pump OPEX depends on electricity price vs. delivered fuel cost; many households see 10–30% annual bill reductions when envelopes are tightened.                                                                                                                                             | Lowers energy burden for cost-stressed homes; protects renters via no-rent-gouging conditions; frees income for food/health/education.                                   |
| Health benefits     | High             | Improved IAQ from sealing, filtration, and venting; fewer combustion byproducts indoors. Likely reductions in asthma triggers and thermal stress.                                                                                                                                                                                                                        | Disproportionate gains where asthma/overcrowding/older housing intersect; aligns with high local asthma prevalence.                                                      |
| Resilience          | High             | Tightened envelopes maintain safe indoor temps longer during outages; dual-fuel or thermal storage options add redundancy; less dependence on fuel deliveries.                                                                                                                                                                                                           | Outage tolerance especially valuable for elders, children, medically vulnerable; reduces emergency displacement risk.                                                    |
| Disbenefits / risks | Moderate         | Upfront capital; cold-weather performance requires proper sizing and backup heat; landlord pass-through risk; contractor capacity constraints. Mitigations: income-based incentives, rent-stability provisions, quality control/commissioning, installer training, phased rollout.                                                                                       | Without guardrails, improvements could raise rents or miss the hardest-to-reach homes; targeted program design keeps benefits centered.                                  |



**Local Renewables + Community Storage (wind/solar + batteries; microgrids; district heat/waste-heat where viable)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                | Community Benefits                                                                                                                          |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Electricity generation emits $\approx 7,900$ mt CO <sub>2</sub> e. Replacing 50–90% of diesel-generated MWh with renewables/storage could abate $\approx 4,000$ –7,000+ mt CO <sub>2</sub> e; larger gains if electrified heating grows while the grid decarbonizes. | Cuts community-wide emissions and enables low-carbon heating/transport; community ownership models can keep savings local.                  |
| Energy cost savings | High (long-term) | Hedging against diesel price volatility; LCOE declines over time; storage reduces curtailment and generator cycling. Near-term bills may be flat to modestly lower; lifecycle savings can be substantial as fuel imports decline.                                    | Stabilizes bills for low-income households; predictable tariffs/supports energy assistance; reduces arrears/shutoff risk.                   |
| Health benefits     | Moderate–High    | Less diesel generation $\rightarrow$ lower local pollutants and noise; indirect indoor benefits as homes electrify on a cleaner grid.                                                                                                                                | Benefits accrue in neighborhoods closest to generation and along supply chains; reduces stressors linked to poor mental/respiratory health. |
| Resilience          | High             | Microgrids + storage provide black-start capability, ride-through for storms/supply disruptions; district heat adds thermal resilience.                                                                                                                              | Critical for clinics, schools, shelters; protects households with limited mobility or medical equipment needs.                              |
| Disbenefits / risks | Low–Moderate     | Capital intensity; O&M capacity; siting/permitting; intermittency without adequate storage; tariff design must avoid regressive cost shifts. Mitigations: phased builds, local O&M training, community benefit agreements, affordability safeguards.                 | Poorly designed tariffs could burden low-income customers; ensure lifeline rates and inclusive governance.                                  |





**Transportation Strategies (EV adoption, municipal fleet electrification, charging infrastructure, active mobility & safety)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                                                                    | Community Benefits                                                                                                                                                                                       |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Transportation accounts for ≈ 31.6% of emissions (~12,400 mt CO <sub>2</sub> e). Trucks dominate (~96% of transport emissions). Full fleet turnover unlikely near-term, but 10–20% reduction (≈1,200–2,500 mt) is plausible over a decade through municipal/school fleet electrification, incremental EV adoption, and reduced fuel use. | Prioritizing school buses, public fleets, and community shuttles ensures benefits reach all residents; reduces dependence on costly imported fuels that disproportionately burden low-income households. |
| Energy cost savings | Moderate         | EV OPEX is generally 50–70% lower per mile than gasoline/diesel in many U.S. contexts. Nome’s high electricity costs partly offset this, but net 20–40% cost reduction is still plausible for fleets and frequent drivers.                                                                                                               | Lower operating costs for essential services (schools, city services) benefit all taxpayers; household EV programs must include rebates/affordability pathways to reach at-risk families.                |
| Health benefits     | Moderate         | Less tailpipe pollution reduces localized PM and NO <sub>x</sub> exposure, particularly along trucking routes and near schools. Benefits smaller than building/energy shifts, but meaningful for asthma-sensitive populations.                                                                                                           | High asthma prevalence means even modest air quality improvements are significant; reduced noise from EVs also improves community well-being.                                                            |
| Resilience          | Moderate         | EVs tied to renewable microgrids provide backup power during outages (vehicle-to-home, vehicle-to-grid). Fleet electrification ensures essential services run even if fuel supply chains are disrupted.                                                                                                                                  | Reliability of emergency/medical services is especially valuable for vulnerable households in storms or supply delays.                                                                                   |
| Disbenefits / risks | Moderate         | Upfront vehicle and charger costs; limited range in extreme cold; reliance on local charging availability; risk of uneven adoption where only wealthier households benefit first. Mitigations: incentives, fleet-first rollouts, winterized charging, subsidies for low-income households.                                               | Without equity guardrails, early EV adoption could widen disparities; public programs must ensure charging in at-risk neighborhoods and financial supports for affordability.                            |

### Workforce Development (retrofits, renewable O&M, electrical/EV maintenance; local hiring & apprenticeships)

| Outcome             | Potential Impact         | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                      | Community Benefits                                                                                                                             |
|---------------------|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate (indirect)      | No direct abatement, but enables rapid adoption in categories above. If programs lift local install/O&M capacity by, say, 50–100% over baseline, they can accelerate realization of thousands of mt CO <sub>2</sub> e in annual reductions from heating and power.         | Ensures transition is done with and by the community; reduces dependency on outside labor that can delay projects.                             |
| Energy cost savings | Moderate (indirect)      | Faster, higher-quality installs reduce rework and downtime; local crews shorten project queues, helping households capture savings sooner.                                                                                                                                 | Keeps wages local; creates career ladders that raise household income and reduce energy insecurity over time.                                  |
| Health benefits     | Moderate (indirect)      | Quality weatherization/ventilation work improves IAQ; faster project delivery brings earlier health gains.                                                                                                                                                                 | Prioritizing at-risk trainees increases culturally competent service delivery; supports trust and uptake in underserved homes.                 |
| Resilience          | Moderate–High (indirect) | Local technicians improve outage response and system reliability; cross-training supports microgrid operations and building maintenance.                                                                                                                                   | Builds self-reliance—critical during storms or supply disruptions when outside crews can’t reach the community quickly.                        |
| Disbenefits / risks | Low–Moderate             | Training without job placement risks attrition; wage leakage if projects still awarded to outside firms; small market may limit steady hours early on. Mitigations: project labor agreements, local hire requirements, multi-year program pipeline, stackable credentials. | Without intentional design, at-risk participants might be under-represented; target recruitment, stipends, childcare, and supportive services. |



### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy costs → reduces high energy burden, frees up income for essentials.
- Improved indoor air quality → addresses asthma and respiratory health burdens.
- More reliable and resilient systems → protects vulnerable households during outages or fuel shortages.
- Local job creation and training → builds economic opportunity, especially for younger populations.
- Community ownership of energy → strengthens sovereignty, autonomy, and long-term affordability.
- Equitable access to clean technologies → ensures vulnerable households benefit from upgrades first.

Potential disbenefits if not designed equitably:

- High upfront costs → risk of excluding low-income households without subsidies or protections.
- Landlord-tenant split incentives → upgrades could lead to rent hikes or displacement if not carefully managed.
- Technology performance in Arctic conditions → risk of underperforming systems without proper design and maintenance.
- Unequal adoption of clean mobility → early EV and infrastructure benefits may skew toward wealthier residents.
- Workforce program gaps → if not well-designed, training may not lead to long-term employment or may bypass at-risk residents.
- Tariff or financing structures → poorly designed cost recovery could unintentionally raise rates for vulnerable households.

### Path Forward

Nome's path toward a more efficient and resilient future lies in addressing the interconnections among housing, energy, transportation, and health. Reducing criteria pollutants and greenhouse gas emissions through cleaner, more efficient systems can simultaneously relieve household energy burdens, improve indoor environments, and strengthen local infrastructure reliability.

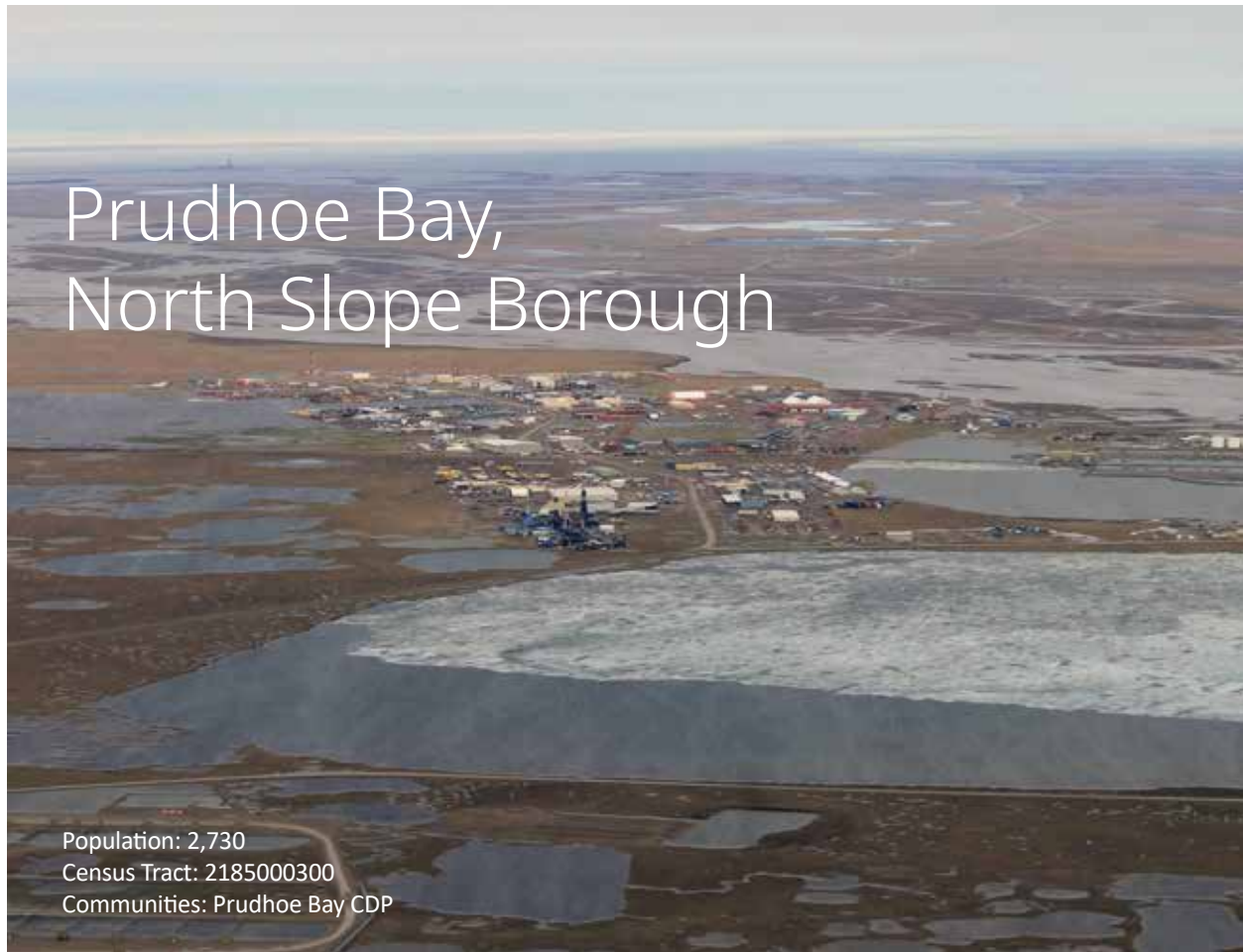
The analysis highlights four primary opportunity areas: improving building energy performance, expanding renewable and resilient energy systems, developing the local workforce, and modernizing transportation. Together, these strategies target the most significant emission sources while creating economic and health benefits across the community.

Moving forward, efforts should focus on:

- Coordinating investments in building efficiency and clean energy to ensure the greatest cumulative benefit.
- Designing equitable programs that prioritize cost relief and access for households facing the greatest economic and health disparities.
- Building local skills and capacity to support long-term energy management and infrastructure maintenance.
- Leveraging partnerships and funding opportunities to scale solutions and share best practices across rural Alaska.

By aligning emissions reduction with community well-being and economic opportunity, Nome can strengthen its energy security, reduce disparities, and build a more sustainable and self-reliant future.





Prudhoe Bay and the North Slope region of Alaska exist at the center of both industrial development and environmental change. The area's economy and infrastructure are closely linked to energy production, creating a unique mix of opportunity and challenge as the region confronts evolving environmental conditions and seeks to manage criteria pollutants and greenhouse gas emissions. Reliance on petroleum-based energy systems, combined with remote Arctic geography, contributes to high operating costs and infrastructure constraints that affect local quality of life and economic stability.

Understanding these dynamics is critical to planning for a resilient future. By addressing the region's high energy intensity, improving efficiency in industrial and community systems, and diversifying energy sources, local stakeholders can strengthen infrastructure performance, reduce emissions, and enhance overall environmental and economic sustainability. This analysis identifies key strategies for advancing these goals in ways that reinforce equity, reduce disparities, and build long-term community resilience.

### Overall Assessment

Most impactful, high-benefit strategies for emission reduction and community co-benefits:

1. Industrial Emissions Reduction (Methane Control + Efficiency + CCS)
2. Renewable Microgrids and Waste-Heat Recovery
3. Community Housing Weatherization and Energy Efficiency

Taken together, these three strategies directly tackle the largest emission sources (industrial combustion, diesel generation, housing fuel use), while producing immediate, tangible benefits for vulnerable residents in the form of lower costs, cleaner air, and more resilient living conditions.



## Emissions Data Overview

Note that these data are for the entire Census Area, which contains three Census Tracts.

Total Modeled Emissions: 304,205 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (94.59 %)

- Residential Sector (6.05%)
  - Electricity: 10,546.64 mt CO<sub>2</sub>e (3.47% of total)
  - Natural Gas: 1,213.22 mt CO<sub>2</sub>e (0.40 % of total)
  - Residual Fuel Oil No. 5: 6,652.40 mt CO<sub>2</sub>e (2.19% of total)
  - Wood & Wood Residuals: 0.36 mt CO<sub>2</sub>e (~0% of total)
- Commercial Sector (73.20%)
  - Distillate Fuel Oil No. 1: 4,092.25 mt CO<sub>2</sub>e (1.35% of total)
  - Natural Gas: 67,367.03 mt CO<sub>2</sub>e (22.15% of total)
  - Propane: 312.40 mt CO<sub>2</sub>e (0.10% of total)
  - Wood & Wood Residuals: 11.36 mt CO<sub>2</sub>e (~0% of total)
  - Electricity: 11,413.43 mt CO<sub>2</sub>e (3.75% of total)
- Industrial Sector
  - Distillate Fuel Oil No 1: 357.41 mt CO<sub>2</sub>e (0.12% of total)
  - Natural Gas: 185,785.35 mt CO<sub>2</sub>e (61.07% of total)

### Transportation (5.41%)

By fuel type:

- Diesel fuel: 6,665.37 mt CO<sub>2</sub>e (2.19 %)
- Motor gasoline: 9,787.54 mt CO<sub>2</sub>e (3.22 %)
- Electricity (for electric vehicles, etc.): 0.07 mt CO<sub>2</sub>e (very small)

By vehicle type (within transport):

- Trucks: 16,044.04 mt CO<sub>2</sub>e (97.51 % of transport emissions)
- Passenger vehicles: 376.13 mt CO<sub>2</sub>e (~2.29 %)
- Motorcycles: 32.82 mt CO<sub>2</sub>e (~0.20 %)
- This suggests heavy reliance on trucks/freight/mobility of goods rather than personal vehicle use.

### Electricity Generation

- Electricity consumption: 78,975.16 MWh
- Generation sources:
  - Petroleum: 69,498.14 MWh → 20,015.46 mt CO<sub>2</sub>e (91.14% of generation emissions)
  - Natural Gas: 9,477.02 MWh → 1,944.68 mt CO<sub>2</sub>e (8.86%)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- The North Slope region is overwhelmingly dominated by stationary combustion, especially in the industrial sector. That suggests that industrial facilities (likely including oil & gas operations, heating, operations support facilities) are responsible for most emissions.
- Natural gas is a major fuel in industrial and commercial sectors.
- Petroleum/diesel remains critical in electricity generation and in transportation.
- Transportation emissions are relatively small in the overall mix, and within transport the vast majority comes from trucks (heavy vehicles).
- Electricity generation is still largely fossil fuel–driven (mostly petroleum), though natural gas plays a nontrivial role in electricity.

## Social Determinants of Health

### Environmental Conditions

- Extreme Weather & Disaster Risk
  - Anticipated changes in extreme weather are moderate (8.52 index).
  - Annualized disaster loss is relatively low at ~\$263,889, ranking in the 15.91 percentile nationally.
- Pollution & Toxic Exposure
  - Diesel PM exposure is reported at zero, suggesting limited diesel particulate matter pollution.
  - Air toxics cancer risk is notable at a score of 8.00.
  - Hazardous waste and toxic release proximity percentile scores are relatively low (1–16th), but RMP facility proximity is high (75.57th percentile), signaling elevated risk from regulated industrial facilities.
- Environmental Infrastructure & Sites
  - No pre-1980s housing noted, but the community does contain formerly used defense sites.
  - Proximity to roads and airports is moderate, which may contribute to noise and localized emissions.

Implications: Prudhoe Bay faces relatively low disaster and pollution burdens compared to many U.S. regions, but the presence of industrial and defense-related risks—along with a significant ranking for regulated facilities—indicates heightened vulnerability to industrial accidents or chemical releases. These conditions could magnify health and safety risks if environmental conditions or infrastructure stresses increase over time.

### Public Health Indicators

- Chronic Conditions
  - Asthma prevalence (3.45%) and diabetes (3.50%) are modest, both below national averages but not negligible.
  - Cancer prevalence is 2.25%, with blood pressure at 14.75%, reflecting mid-range risk levels.
  - Poor mental health prevalence is 4.85%, suggesting meaningful but not extreme mental health burdens.
- Mortality & Life Expectancy
  - Reported average life expectancy is 0.00 (likely unmeasured or suppressed due to small population size).
  - National percentile scores place heart disease and cancer prevalence near the 40th percentile, not especially high but relevant in small, isolated populations.

Implications: The health profile shows moderate chronic disease prevalence, but mental health concerns are notable. In an isolated Arctic environment, even moderate health burdens are magnified by limited access to medical infrastructure. This creates a fragile baseline for community resilience in the face of environmental and environment-related stressors.

### Socioeconomic Factors

- Poverty & Income
  - Poverty is low (8.97%) compared to national averages, and unemployment is just 0.8%.
  - However, income inequality is extremely high, with a GINI index ranking at the 100th percentile nationally.
- Housing & Costs
  - Housing cost burden is significant (38.83%), ranking in the 86.93rd percentile, even though reported median home value is \$0 (likely due to limited owner-occupied housing).
  - Renter occupancy is low (10.6%), but the high housing burden suggests affordability challenges.
- Access & Social Resources
  - Nearly 25% of residents lack internet access, placing the community in the 84th percentile nationally for digital exclusion.
  - Insurance coverage is relatively stable (6.3% uninsured).
  - The population is young overall, with only 5% over 65 and no reported population under 17.
  - Disability prevalence is modest at 6.5%.

**Implications:** While poverty and unemployment are low, severe income inequality and high housing cost burdens create structural vulnerabilities. Limited internet access exacerbates isolation, constraining education, employment, and healthcare opportunities. These socioeconomic stressors may amplify inequities in environmental adaptation and emissions reduction efforts.

### Transportation Insecurity

- **Access & Cost** - All indicators (transportation access, cost burden, and safety) report as 0.00, suggesting either a lack of available data or atypical community structures due to Prudhoe Bay's role as an industrial work site.
- **Mobility Context** - The absence of data may reflect that the majority of population is tied to oil field operations with employer-provided or controlled transportation, limiting typical measures of insecurity.

**Implications:** Transportation in Prudhoe Bay appears institutionally managed rather than individually accessible. While this may reduce direct household burdens, it makes the community highly dependent on industry infrastructure—an important vulnerability if environmental impacts or emissions reduction strategies alter industrial operations.

### Intersection with Emissions Reduction Planning

- **Industrial Dependence:** The community's exposure to regulated facilities and defense sites suggests that industrial activity dominates local life. Any emissions reduction strategy will intersect heavily with these operations.
- **Fragile Health & Infrastructure:** Moderate chronic disease burdens and limited healthcare access mean that health resilience is low, making the community sensitive to both direct and indirect environmental health impacts.
- **Inequality & Access Gaps:** High income inequality, significant housing burdens, and limited internet access highlight disparities that could cause uneven benefits—or harms—from sustainability initiatives.
- **Institutional Control of Resources:** Housing, transportation, and economic activity appear tied to industrial structures. This creates both an opportunity for systemic change through industry-driven initiatives and a risk if sustainability measures reduce employment or access without mitigation planning.



## Mitigation Strategies

### Industrial Emissions Reduction & Energy Transition

The overwhelming share of emissions in the region comes from stationary industrial combustion, especially natural gas and fuel oil used in oilfield operations and support facilities. Given Prudhoe Bay's role as a hub for fossil fuel extraction, targeted industrial mitigation is essential.

- Methane leak detection and repair (LDAR): Reducing fugitive emissions from oil and gas operations.
- Electrification of operations: Shifting auxiliary and support systems (e.g., pumps, compressors) from fossil fuels to renewable electricity where feasible.
- Carbon capture and storage (CCS): Integrating CCS at large stationary sources to reduce direct CO<sub>2</sub> emissions from industrial activity.
- Low-carbon fuels: Incorporating cleaner hydrogen blends or synthetic fuels in place of diesel for industrial equipment.

Implication: This category aligns directly with emissions dominance in Prudhoe Bay. However, strategies must be balanced with the community's dependence on oilfield infrastructure for jobs, housing, and transportation.

### Renewable & Distributed Energy Systems

Electricity generation in the region is still heavily petroleum-based, with natural gas supplementing it. At the same time, households and commercial facilities carry a high housing cost burden and limited internet access, compounding energy vulnerability.

- Microgrids powered by renewables: Wind, solar, and storage can reduce reliance on imported diesel while improving resilience.
- Waste heat recovery and district energy: Leveraging industrial processes to heat residential and community spaces.
- Community-scale solar and battery systems: Deploying rooftop or ground-mounted solar paired with storage to reduce household energy burdens.
- Hybrid systems for critical facilities: Health clinics, schools, and emergency facilities equipped with renewable-powered backup systems to enhance community resilience.

Implication: Expanding renewable microgrids would simultaneously reduce emissions, lower energy costs, and improve community self-reliance in a remote environment.

### Transportation & Logistics Decarbonization

Though smaller in total share, transportation emissions in the North Slope come overwhelmingly from heavy trucks, directly linked to industrial operations. Given Prudhoe Bay's dependence on employer-provided or industry-managed transport, targeted logistics strategies are impactful.

- Electrification of fleet vehicles: Transitioning light-duty passenger and service vehicles to EVs with charging supported by renewables.
- Low-carbon fuels for heavy trucks: Blending biodiesel, renewable diesel, or hydrogen for industrial trucking fleets.
- Efficient freight logistics: Coordinating supply chains to reduce redundant trips and idling.
- Shared mobility for workers: Employer-led transportation pooling systems to reduce per-capita emissions.

Implication: Transportation strategies must focus on the industrial backbone of trucking rather than personal mobility, reflecting Prudhoe Bay's unique setting.

### Community Health, Housing, & Energy Efficiency

The social determinants of health data highlight inequities: high housing cost burdens, limited internet access, and modest but notable chronic health burdens (mental health, diabetes, hypertension). Addressing housing quality and energy efficiency provides dual benefits for health and emissions.



- Building weatherization and retrofits: Reduce heating demand, lowering both emissions and costs for households and employers.
- High-efficiency appliances and HVAC systems: Deploy efficient heating systems that reduce reliance on fuel oil.
- Indoor air quality improvements: Address occupational and housing exposures, particularly given industrial proximity.
- Telehealth and remote education infrastructure: Supported by expanded broadband, reducing the need for emissions-intensive travel.

Implication: Energy efficiency investments reduce both emissions and direct community cost burdens, while also enhancing health resilience in extreme Arctic conditions.

### Resilient Infrastructure & Workforce Transition

Finally, long-term mitigation must consider structural inequities and reliance on the oil industry for jobs, transport, and housing. High income inequality in the region underscores the importance of equitable transition planning.

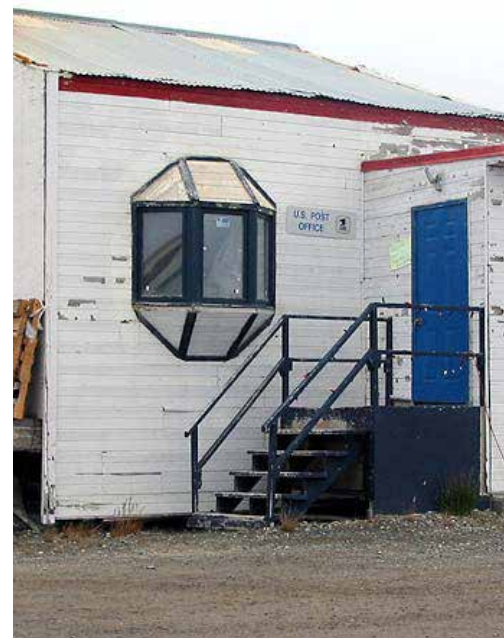
- Workforce training in clean energy sectors: Preparing residents and transient workers for employment in renewable energy, CCS, and resilience projects.
- Resilient housing and public facilities: Building to withstand extreme Arctic weather while integrating energy-efficient and low-carbon designs.
- Collaborative governance with industry: Structured agreements ensuring that sustainability strategies do not undermine worker housing or access, but instead create joint benefits.
- Emergency preparedness systems: Enhanced disaster response capacity given environmental hazards and industrial risks.

Implication: Linking workforce transition and resilience planning ensures mitigation strategies are not just technically effective, but socially sustainable in a community deeply tied to extractive industries.

### Improved Outcomes for Overburdened and Underserved Communities

Investing in targeted sustainability and adaptation strategies in the Prudhoe Bay, have the potential to deliver significant co-benefits. By reducing reliance on costly imported fuels through renewable microgrids, weatherization, and energy efficiency upgrades, households experiencing high housing cost burdens will see lower monthly expenses, improved indoor comfort, and reduced exposure to harmful pollutants. Expanding broadband access and digital infrastructure will enhance access to telehealth, remote education, and workforce opportunities, addressing both health inequities and economic disparities.

These improvements strengthen overall community resilience by reducing vulnerability to extreme weather, industrial accidents, and disruptions in oil-based infrastructure. As health outcomes improve—particularly for residents with elevated rates of hypertension, diabetes, and poor mental health—so too does community capacity to engage in long-term planning and transition efforts. In this way, emissions reduction strategies not only reduce emissions but also create healthier, more equitable, and more sustainable futures for vulnerable households in Prudhoe Bay and across the North Slope.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Industrial Emissions Reduction & Energy Transition (LDAR, electrifying auxiliaries, efficiency, CCS, low-carbon fuels)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                             | Community Benefits                                                                                                                                                           |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Largest source is stationary industrial combustion (majority share of borough emissions). LDAR can cut methane 40–80% at leaking assets; electrifying auxiliary loads + efficiency often yields 5–15% site CO <sub>2</sub> e cuts; CCS can capture 50–90% at specific stacks (project-dependent). | Cuts the pollution burden closest to where workers/ live-in staff spend time; lowers episodic risk from industrial emissions affecting nearby workers and temporary housing. |
| Energy cost savings | Moderate         | LDAR is net-savings positive; efficiency often <5-yr payback. CCS adds OPEX (parasitic load); electrification economics hinge on local power costs vs. gas/diesel.                                                                                                                                | Savings can stabilize employer-provided housing/transport costs that are indirectly borne by lower-income workers.                                                           |
| Health benefits     | Moderate–High    | Fewer combustion hours/leaks → lower co-pollutants (NO <sub>x</sub> , SO <sub>2</sub> , ultrafine PM). Expected improvements in respiratory/ cardiovascular risks among exposed workers/residents.                                                                                                | Shift workers and camp residents gain most from reduced on-site emissions and better air.                                                                                    |
| Resilience          | Moderate         | Electrified/efficient systems + tighter sites reduce fuel logistics exposure; CCS adds complexity but can diversify compliance pathways.                                                                                                                                                          | Reliability during storms/ freight disruptions benefits workers who rely on employer energy/heat.                                                                            |
| Disbenefits / risks | Moderate         | CCS capital intensity; added water/use and cold-weather integration risk; potential workforce disruption from process changes; need for new skills.                                                                                                                                               | If not paired with training, vulnerable workers risk being left out of higher-skill roles; ensure local hire & upskilling.                                                   |



**Renewable & Distributed Energy Systems (wind/solar + storage microgrids, waste-heat/district energy, community solar)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                       | Community Benefits                                                                                                 |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Replacing diesel/petroleum-fired generation can displace >70–90% of kWh at sites with good resources/storage; waste-heat recovery can offset 10–30% of building heat.       | Prioritizing low-income accounts and public facilities maximizes equitable reductions in local emissions exposure. |
| Energy cost savings | High             | Diesel parity often exceeded in remote Arctic: avoided fuel + logistics; community solar can cut bills 5–20% depending on design; waste-heat lowers heating fuel purchases. | Greatest relief for households with high housing/energy burdens; can structure inclusive tariffs and bill credits. |
| Health benefits     | Moderate         | Less diesel runtime → less PM <sub>2.5</sub> /NO <sub>x</sub> ; district heat improves indoor air by reducing in-home combustion.                                           | Benefits stack for vulnerable households with older HVAC or crowded housing.                                       |
| Resilience          | High             | Microgrids with storage keep clinics/shelters powered; less dependence on weather-sensitive fuel deliveries; district systems provide stable heat.                          | Critical for disadvantaged residents with fewer backup options during outages/extreme cold.                        |
| Disbenefits / risks | Low–Moderate     | Intermittency if storage is undersized; O&M capacity and parts logistics; tariff design must avoid cost-shifts to non-participants.                                         | Guardrails needed so low-income customers are not excluded by upfront costs or stranded with higher rates.         |

**Transportation & Logistics Decarbonization (EVs for light-duty fleets, low-carbon fuels for heavy trucks, anti-idling, logistics optimization)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                    | Community Benefits                                                                                  |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Transport is a smaller share locally but truck-heavy; optimizing freight + low-carbon diesel can trim 10–25% for heavy duty ops; LD EV fleet swaps cut 50–70% per vehicle (well-to-wheel mix dependent). | Cleaner trucks and buses reduce exposure along worker routes and near camps/facilities.             |
| Energy cost savings | Moderate         | EVs: lower fuel/maintenance; heavy-duty low-carbon fuels can be cost-neutral to premium; savings scale with anti-idling & routing software.                                                              | Lower employer fleet costs can curb pass-through costs on housing/transport for lower-wage workers. |
| Health benefits     | Moderate         | Reduced diesel exhaust near loading areas and housing; fewer cold-start events/idle hours.                                                                                                               | Lower-income workers in logistics yards and shuttle riders benefit most.                            |
| Resilience          | Moderate         | Diversifies fuels; local charging tied to microgrids boosts continuity during fuel supply delays.                                                                                                        | Ensures essential worker mobility when weather disrupts fuel shipments.                             |
| Disbenefits / risks | Low–Moderate     | Charging build-out in extreme cold; battery performance loss; alternative fuels supply risk; training needs for techs.                                                                                   | Avoid siting inequities—ensure chargers available to shared fleets that serve lower-income workers. |

**Community Housing, Weatherization & Health (deep envelope retrofits, efficient HVAC/heat pumps where viable, IAQ upgrades, broadband-enabled telehealth)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                      | Community Benefits                                                                                           |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Building efficiency commonly yields 15–35% heating fuel cuts per unit; in hydro-served areas, heat pumps can nearly eliminate heating emissions; Prudhoe housing mix may be employer-managed—scope varies. | Targeted upgrades in lower-income housing deliver outsized per-dollar reductions due to higher baseline use. |
| Energy cost savings | High             | Weatherization often saves 20–30% on heating fuel; paybacks strong where delivered fuel prices are high.                                                                                                   | Direct bill relief for cost-burdened households; reduces arrears/energy insecurity.                          |
| Health benefits     | High             | Better IAQ, moisture control, ventilation → fewer asthma/COPD flares; thermal comfort reduces stress/mental-health triggers.                                                                               | Health gains accrue fastest to vulnerable residents in older or crowded units.                               |
| Resilience          | High             | Tighter envelopes hold heat during outages; backup ventilation/filtration improves smoke/event response; broadband supports telehealth during storms.                                                      | Critical for residents with limited mobility or access to care.                                              |
| Disbenefits / risks | Low              | Over-tightening without ventilation; contractor capacity; split-incentive in employer/tenant settings.                                                                                                     | Design programs to cover up-front costs and require balanced ventilation to avoid IAQ pitfalls.              |

**Resilient Infrastructure & Workforce Transition (upskilling, local hire, resilient public facilities, emergency power/heat, governance with industry)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                         | Community Benefits                                                                              |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate     | Indirect but enables other measures; resilient facilities and trained workforce accelerate adoption and keep projects online. | Ensures vulnerable communities actually receive—and can maintain—low-carbon assets.             |
| Energy cost savings | Moderate         | Resilient, efficient public buildings cut government OPEX; savings can be redirected to services.                             | More stable local services (schools/clinics) in vulnerable areas; reduced emergency diesel use. |
| Health benefits     | Moderate         | Reliable clinics/shelters, fewer cold-weather failures; steadier access to care and meds.                                     | Vulnerable residents benefit most from dependable essential services.                           |
| Resilience          | High             | Hardening power/heat, diversified supply, and trained local technicians reduce outage duration and recovery time.             | Narrows inequities during disasters when low-income households face the longest recovery.       |
| Disbenefits / risks | Low–Moderate     | Transition anxiety/workforce displacement if not planned; training pipeline/time; coordination load on small entities.        | Embed paid training/apprenticeships and local hire requirements to avoid exclusion.             |



### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy costs → Weatherization, efficiency upgrades, and renewable microgrids reduce heating and electricity burdens, directly benefiting cost-burdened families.
- Improved health outcomes → Cleaner air from reduced diesel/industrial emissions lowers asthma, hypertension, and cardiovascular risks.
- Resilience in extreme weather → Reliable microgrids, insulated housing, and diversified transport reduce vulnerability during outages and disasters.
- Economic opportunity → Workforce training in clean energy and infrastructure provides pathways for local employment and skills development.
- Equity in service delivery → Broadband expansion and telehealth access help bridge health care and education gaps for vulnerable populations.

Potential disbenefits if not designed equitably:

- High upfront costs → Without subsidies, at-risk households may be excluded from renewable/efficiency upgrades.
- Risk of inequitable tariffs or cost-shifts → Poorly designed energy programs can increase bills for non-participants.
- Workforce transition challenges → Workers tied to oilfield operations may face job insecurity if not offered retraining.
- Technology reliability risks → Extreme Arctic conditions can undermine performance of new technologies (e.g., batteries, heat pumps).
- Implementation capacity gaps → Limited local contractors or technical expertise could delay or reduce access for at-risk communities.

### Path Forward

Prudhoe Bay's environmental and community context presents both significant challenges and critical opportunities. The dominance of industrial combustion, petroleum-based power generation, and energy-intensive housing means that targeted interventions can deliver meaningful emissions reductions while also lowering household costs and improving public health. At the same time, the social determinants of health reveal persistent inequities—particularly for low-income and communities—that make equity-centered design essential for any emissions reduction strategy to succeed.

The path forward requires a balanced approach:

- Industrial emissions strategies must focus on methane control, efficiency, and carbon capture where feasible, while embedding workforce training to protect and advance job opportunities for workers.
- Renewable microgrids and waste-heat recovery systems should be scaled to reduce diesel reliance, enhance resilience, and lower energy burdens across the community.
- Housing weatherization and efficiency programs should prioritize households experiencing high cost burdens, ensuring direct relief and improved living conditions.
- Transportation and resilience investments must be designed to complement these efforts, diversifying energy sources, strengthening critical infrastructure, and preparing the workforce for a low-carbon future.

The path forward involves a balanced, integrated approach that links emissions reduction with tangible improvements in local infrastructure and quality of life. By combining technical innovation, workforce development, and community investment, the North Slope can reduce emissions, adapt to changing environmental conditions, and strengthen the foundations for a sustainable Arctic economy. These measures, pursued collaboratively, will help ensure that the benefits of environmental progress are shared broadly across industries and communities alike.

# Utqiagvik, North Slope Borough



Population: 4,559  
Census Tract: 2185000100

Utqiagvik, the northernmost community in the United States, faces a distinct combination of environmental, health, and social conditions that shape its current challenges and future opportunities. The community's emissions profile is primarily driven by heating and energy use in buildings, diesel-based electricity generation, and heavy-duty transportation. These energy needs are compounded by high rates of asthma, diabetes, and poor mental health, as well as economic and housing disparities that influence access to safe, efficient, and affordable living conditions. Together, these factors create both constraints and opportunities for improvement—where actions to reduce criteria pollutants and greenhouse gas emissions can also improve public health, energy reliability, and economic stability.

This analysis identifies priority strategies that address Utqiagvik's largest sources of emissions while advancing equity and community well-being. By focusing on building efficiency, renewable energy development, and modernized transportation systems, the region can pursue practical and measurable steps toward a more resilient and sustainable future.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Building Energy Efficiency & Housing Resilience
2. Renewable Energy Expansion & Diesel Displacement
3. Sustainable Heavy-Duty Transportation (Fleet & Freight Focus)

Based on the emissions profile of Utqiagvik and the social determinants of health context, three strategies clearly rise to the top for delivering both significant emissions reductions and meaningful benefits (health, equity, and resilience).

## Emissions Data Overview

Total Modeled Emissions: 41,816 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (81.74%)

- Residential Sector (8.54%)
  - Electricity: 3,571.20 mt CO<sub>2</sub>e (8.54% of total)
- Commercial Sector (73.20%)
  - Natural Gas: 28,698.83 mt CO<sub>2</sub>e (68.63% of total)
  - Electricity: 1,908.52 mt CO<sub>2</sub>e (4.56% of total)
- Industrial Sector: 0%. No direct emissions from industrial combustion processes were reported.

### Transportation (18.26%)

- By Fuel Type:
  - Diesel Fuel: 3,093.92 mt CO<sub>2</sub>e (7.40% of total)
  - Motor Gasoline: 4,543.17 mt CO<sub>2</sub>e (10.86% of total)
  - Electricity (for vehicles): 0.01 mt CO<sub>2</sub>e (negligible)
- By Vehicle Type:
  - Trucks (e.g. heavier, commercial, freight): 7,447.30 mt CO<sub>2</sub>e (97.51% of transportation emissions)
  - Passenger vehicles: 174.57 mt CO<sub>2</sub>e (2.29%)
  - Motorcycles: 15.23 mt CO<sub>2</sub>e (0.20%)

### Electricity Generation

- Electricity consumption: 47,567.12 MWh
- Generation sources:
  - Wind: ~ 9,513.42 MWh → 0.00 mt CO<sub>2</sub>e
  - Hydro: ~ 19,026.85 MWh → 0.00 mt CO<sub>2</sub>e
  - Diesel generation: ~ 19,026.85 MWh → ~ 5,479.73 mt CO<sub>2</sub>e (100% of the electricity-generation emissions)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- Stationary combustion (especially commercial natural gas use) is by far the dominant emissions source (81.74%) in Utqiagvik.
- Transportation contributes ~ 18.26%, with heavy trucks being the major source, and gasoline & diesel being the main fuels.
- Electricity generation—while a smaller share relative to stationary combustion—is entirely reliant on diesel, leading to ~ 5,479.7 mt CO<sub>2</sub>e emissions.
- Renewable sources (wind, hydro) are present and generate power without associated emissions (in this accounting model).



## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather & Disasters:** Anticipated changes in extreme weather measure at 1.70, with annualized disaster loss at the 10th percentile nationally. While dollar losses are relatively low (\$157K annually), the community faces heightened vulnerability given its remote location and reliance on infrastructure.
- **Air Quality & Exposure:** Diesel particulate matter (PM) exposure is reported at 0.00, with no significant toxic releases or hazardous site proximity. Air toxics cancer risk, however, is elevated at 9.00.
- **Built Environment & Hazards:** Formerly used defense sites are present, indicating possible contamination risks. Pre-1980s housing accounts for 38% of occupied homes, with aging infrastructure potentially contributing to indoor air quality issues. Airport proximity is moderate (6% of tract, 31st percentile nationally), underscoring reliance on aviation.
- **Arctic permafrost thaw** could create unmeasured risks not captured here.

Implications: Utqiaġvik's environmental conditions suggest moderate-to-high exposure to health risks from aging infrastructure and legacy contamination. Although current measured pollution levels are low, the community remains environmentally vulnerable due to historical military activity, extreme weather exposure, and reliance on limited infrastructure.

### Public Health Indicators

- **Chronic Disease Burden:** Asthma prevalence is extremely high (11%, 99th percentile nationally), paired with high diabetes prevalence (10%, 96th percentile), and elevated rates of high blood pressure (30%, 87th percentile). Cancer prevalence (4.2%) is above average (70th percentile).
- **Mental & Behavioral Health:** Poor mental health prevalence is strikingly high at 15.3% (99th percentile), reflecting stressors tied to isolation, cultural disruptions, and environmental stress.
- **Heart Disease & Longevity:** Heart disease falls at the 41st percentile, while average life expectancy is strong (80 years). Despite health challenges, longevity may reflect resilience and protective cultural/community factors.

Implications: Utqiaġvik faces disproportionate burdens of asthma, diabetes, and poor mental health compared to the rest of the U.S., placing pressure on limited healthcare capacity. These conditions increase sensitivity to additional environmental and environment-related stressors.

### Socioeconomic Factors

- **Poverty & Employment:** Roughly 26% of residents live below 200% of the federal poverty line, and unemployment is extremely high (12.2%, 95th percentile).
- **Education & Access:** 13.6% of adults lack a high school diploma (91st percentile), and internet access gaps affect more than one-quarter of households (85th percentile).
- **Housing & Insurance:** Nearly 60% of units are renter-occupied (88th percentile), with 24% uninsured (94th percentile). While housing cost burden is moderate (19%), instability in rental housing reduces long-term security.
- **Demographics:** A young population (37% under 17, 96th percentile) creates high dependency needs, while 8% of residents are over 65 (also 96th percentile nationally), showing both youth-driven and eldercare challenges. Disability prevalence is 12.6%, aligning with national averages.

Implications: Utqiaġvik's socioeconomic profile reveals high unemployment, educational barriers, and low insurance coverage, coupled with large youth and elder populations. These dynamics limit adaptive capacity, making the community more vulnerable to shocks from environmental and policy changes.



### Transportation Insecurity

- **Access & Cost:** Transportation access scores are low (34th percentile), reflecting limited options in this remote Arctic setting. Costs represent just 0.11% of household burden, but this likely reflects a reliance on local or subsidized systems rather than true affordability.
- **Safety:** Traffic-related fatalities are reported as zero, which is consistent with limited road infrastructure.

Implications: Limited transportation access is a structural challenge in Utqiaġvik. While cost burdens appear low, dependence on air and seasonal routes creates fragility in supply chains and limits emergency response capacity.

### Intersection with Emissions Reduction Planning

The interplay of these factors has direct consequences for how Utqiaġvik may approach emissions reduction planning:

- **Health Burden Sensitivity:** High asthma and diabetes prevalence mean that any strategy must consider health co-benefits, such as reducing indoor air pollution and reliance on diesel generation.
- **Economic Fragility:** High unemployment and poverty will limit household-level participation in costly energy transitions. Programs must be highly subsidized or community-driven.
- **Infrastructure Vulnerability:** Aging housing stock and reliance on defense-era infrastructure may require significant retrofits, with equity concerns guiding prioritization.
- **Youth & Elders at Risk:** Demographic patterns increase urgency for protective measures, since both young and older populations are less able to withstand environment-related stress.
- **Transportation Constraints:** Any supply-chain-heavy or infrastructure-dependent strategy will face logistical challenges. Plans must account for the high cost and seasonal variability of transport.

Overall, Utqiaġvik's social determinants of health reveal a community with high resilience but constrained adaptive capacity. Emissions reduction strategies must be designed to alleviate—not exacerbate—existing inequities while accounting for local health, economic, and infrastructure realities

## Mitigation Strategies

### Building Energy Efficiency and Housing Resilience

Utqiaġvik's stationary combustion emissions—particularly from commercial natural gas use and residential energy demand—account for the majority of the city's emissions footprint. At the same time, aging housing stock, high asthma prevalence, and energy insecurity reveal that buildings are both a health and sustainability challenge.

Key Strategies:

- Deep energy retrofits of older housing and community facilities, including insulation, weatherization, and high-efficiency heating systems.
- Electrification of heat where feasible, paired with renewable generation (wind/solar hybrids, microgrids) to reduce reliance on diesel and natural gas.
- Indoor air quality improvements through ventilation upgrades and moisture/mold remediation, addressing the high asthma and respiratory health burden.
- Community-scale retrofitting programs targeting rental units (60% of housing stock), ensuring equitable access for renters, not just homeowners.

Why this matters: Improvements in building performance would reduce emissions from natural gas and diesel heating, lower energy bills for households already under economic stress, and directly improve respiratory and mental health outcomes.

## Renewable Energy Expansion and Diesel Reduction

Currently, diesel-based electricity generation contributes a significant share of emissions (over 5,400 mt CO<sub>2</sub>e annually). While Utqiagvik has some wind generation, diesel remains central to powering homes, institutions, and transportation.

Key Strategies:

- Hybrid renewable microgrids that expand the contribution of wind, explore solar (even in low-light months, with battery storage), and integrate demand management tools.
- Diesel displacement projects using advanced storage technologies (e.g., flow batteries, hydrogen pilots) that enable intermittent renewable energy to serve as baseload.
- District heating systems powered by renewable energy for high-use community buildings (schools, health centers) to reduce commercial sector gas reliance.
- Energy security programs that train local residents in maintenance of renewable and storage systems, creating employment and ensuring self-sufficiency.

Why this matters: Expanding renewables would directly reduce diesel emissions while also mitigating public health risks tied to indoor and outdoor air pollution. This approach aligns with energy sovereignty goals, addressing both environmental and economic resilience.

## Sustainable and Efficient Transportation

Transportation emissions in Utqiagvik are dominated by heavy-duty trucks and freight vehicles, with passenger vehicle use contributing relatively little. Given high asthma prevalence and limited infrastructure, reducing transportation emissions requires both innovation and pragmatism.

Key Strategies:

- Fleet electrification of municipal and community vehicles (school buses, service trucks) paired with renewable-powered charging stations.
- Freight efficiency improvements through better logistics, route optimization, and shared cargo systems to reduce redundant heavy trucking.
- Small-scale pilot projects for electrified snowmobiles, ATVs, and other community-use vehicles, reflecting local mobility patterns.
- Active transport investments (safe walking paths, micro-mobility pilots) to encourage low-emission movement where feasible.

Why this matters: Reducing diesel and gasoline reliance in transportation would improve local air quality, directly benefiting respiratory health. Because truck emissions dominate, efficiency and electrification in heavy-duty transport will have outsized benefits compared to private vehicle programs.

## Health-Centered Adaptation and Resilient Infrastructure

High rates of asthma, diabetes, and poor mental health in Utqiagvik mean emissions reduction must also improve health resilience. Infrastructure built in an era of defense installations and oil dependency has left legacy contamination risks, while permafrost thaw threatens housing and utilities.

Key Strategies:

- Sustainable health infrastructure, ensuring clinics and schools are resilient to permafrost shifts, storms, and power disruptions.
- Health co-benefit framing in all energy projects—for example, prioritizing clean indoor heating to address asthma, and reducing noise/air pollution from diesel generators.
- Community mental health programs embedded in sustainability projects, reducing stress and trauma from environmental uncertainty by involving youth and elders in solution design.
- Resilient public spaces that combine green infrastructure with cultural and community gathering sites, improving both social cohesion and environmental adaptation capacity.

Why this matters: Linking mitigation to health ensures broader community support and delivers immediate quality-of-life improvements, addressing not only emissions but also the disproportionate disease burden.

### Improved Outcomes for Overburdened and Underserved Communities

Utqiagvik's roadmap highlights how targeted actions to reduce emissions can simultaneously strengthen community health and economic security. The most effective strategies—improving building energy performance, expanding renewable energy to reduce diesel dependence, and upgrading essential transportation systems—offer immediate benefits through lower energy costs, cleaner air, and more reliable local services. These actions also help address long-standing disparities by improving conditions in homes, schools, and public facilities where needs are greatest.

The path forward emphasizes steady, phased progress. Early efforts should concentrate on cost-effective retrofits in public and residential buildings, integration of renewable power into existing systems, and pilot programs for efficient fleet and freight operations. Parallel investments in local workforce development, housing protections, and community engagement will ensure these measures are equitable and durable. Through this approach, Utqiagvik can achieve meaningful reductions in emissions while building a stronger, healthier, and more resilient community for the future.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

#### Building Energy Efficiency & Housing Resilience

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                           | Community Benefits                                                                                                             |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Deep envelope + heat system upgrades typically cut heating energy 20–40% per building; portfolio programs across public facilities + rentals can deliver double-digit % cuts in community stationary emissions. | Prioritize older/rental housing and community facilities to reduce energy burdens where asthma/overcrowding risks are highest. |
| Energy cost savings | High             | Typical Arctic retrofits yield \$500–\$2,000+/yr per home; larger savings possible in leaky buildings and public facilities.                                                                                    | Low-income renters benefit if incentives require tenant-first protections (no rent hikes, bill-credit pass-throughs).          |
| Health benefits     | High             | Better ventilation, moisture/mold control, and cleaner heating reduce asthma triggers and indoor PM; comfort gains improve mental well-being.                                                                   | Targets households with high respiratory burden; reduces exposure for elders/youth who spend more time indoors.                |
| Resilience          | High             | Weatherization + air sealing improve shelter-in-place performance during outages; building durability against permafrost-related shifts improves habitability.                                                  | Protects those least able to relocate during shocks; focuses on community shelters/schools/clinics.                            |
| Disbenefits / risks | Low–Moderate     | Contractor scarcity, higher upfront costs; risk of split incentives for renters; ventilation mis-tuning can trap pollutants if not commissioned properly.                                                       | Mitigate via local workforce training, quality assurance, and renter protections to avoid displacement or cost pass-throughs.  |

**Renewable Energy Expansion & Diesel Reduction (microgrids, storage, district heat)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                          | Community Benefits                                                                                                        |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Each MWh shifted from diesel to renewables avoids ~0.7–0.9 tCO <sub>2</sub> e/MWh (order of magnitude); expanded wind/solar + storage can displace a meaningful share of generation emissions. | Community-owned assets can channel savings into rate relief and priority services; reduces exposure to fuel price spikes. |
| Energy cost savings | Moderate–High    | Levelized cost declines as storage scales; fuel savings compound over time, especially when diesel delivery is costly/seasonal.                                                                | Design tariffs so low-income households see automatic bill credits; community facilities get predictable budgets.         |
| Health benefits     | Moderate         | Less diesel runtime lowers local air/noise; indirect indoor air gains via electrified or cleaner heat in public buildings.                                                                     | Benefits communities closest to generators and densely occupied housing; supports clinic/school air quality.              |
| Resilience          | High             | Microgrids with storage enable islanding, smoother black-start, and power quality; district heat cuts outage vulnerability for critical facilities.                                            | Prioritize clinics, schools, and elder housing for heat and power continuity.                                             |
| Disbenefits / risks | Moderate         | Intermittency, O&M capacity needs; winter solar limits; capital intensity; technology mismatch without good resource assessment.                                                               | Address through local O&M training, phased pilots, and community governance; avoid rate shocks by pacing investment.      |





**Sustainable & Efficient Transportation (fleet electrification, freight efficiency, micromobility)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                  | Community Benefits                                                                                                   |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Heavy-duty vehicles dominate local transport emissions; electrifying municipal/school fleets and optimizing freight logistics can trim a material share despite limited roadway miles. | Cleaner school buses and service vehicles directly protect children and elders from tailpipe exposure.               |
| Energy cost savings | Moderate         | EVs lower fuel/maintenance costs; savings scale with duty cycle and electricity pricing; route optimization reduces redundant trips.                                                   | Lower municipal OPEX can free funds for public services; fare-free or reduced-fare pilots aid low-income riders.     |
| Health benefits     | Moderate         | Reduced diesel exhaust and noise near homes, schools, and clinics; fewer cold-start emissions.                                                                                         | High relevance where trucks idle near at-risk neighborhoods and community hubs.                                      |
| Resilience          | Moderate         | On-site charging tied to microgrids supports emergency mobility; fewer fuel deliveries needed.                                                                                         | Ensures essential services (medical, food distribution) can operate during supply disruptions.                       |
| Disbenefits / risks | Low–Moderate     | Cold-weather range loss; charger siting; upfront costs; limited models for Arctic duty cycles.                                                                                         | Mitigate via block-heater integration, depot charging, and pilots before scaling; avoid cost pass-throughs in fares. |

**Health-Centered Infrastructure & Resilient Public Facilities**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                          | Community Benefits                                                                                                  |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate     | Direct GHG cuts are smaller unless paired with efficiency/electrification; main value is avoided losses and steady operations. | When bundled with retrofits, clinics/schools can still deliver meaningful reductions.                               |
| Energy cost savings | Moderate         | Hardening + controls lower waste energy (leakage, standby); fewer emergency repairs.                                           | Stable facility budgets protect essential services that at-risk residents rely on.                                  |
| Health benefits     | High             | Better IAQ, thermal stability, and backup power reduce asthma events, medication spoilage, and care interruptions.             | Elevates outcomes for youth/elders and chronically ill residents; improves mental well-being via reliable services. |
| Resilience          | High             | Structural retrofits, backup systems, and permafrost-aware designs reduce service outages during storms/thaw.                  | Keeps shelters, clinics, schools open when most needed.                                                             |
| Disbenefits / risks | Low              | Construction disruption; mis-sequenced upgrades can cause temporary access limits.                                             | Plan off-season work windows, maintain access accommodations, and communicate early with residents.                 |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy costs → improves affordability for low-income renters and elders on fixed incomes.
- Improved indoor air quality → reduces asthma triggers and respiratory illness, especially for children and elders.
- Local workforce training and jobs → builds capacity and self-sufficiency, addressing unemployment and poverty.
- Greater reliability of critical services → schools, clinics, and community shelters stay functional during outages.
- Enhanced community sovereignty → locally managed energy systems support Iñupiat knowledge and cultural continuity.
- Youth engagement in sustainability work → empowers the next generation, who represent a large share of Utqiagvik's population.



Potential disbenefits if not designed equitably:

- High upfront costs → without subsidies, may exclude vulnerable households.
- Risk of cost pass-throughs to renters → efficiency upgrades could raise rents if protections are absent.
- Technical and maintenance challenges → reliance on outside contractors could create fragility.
- Cultural mismatch in program design → solutions not aligned with community priorities risk poor adoption.
- Technology reliability in Arctic conditions → performance limits of EVs, batteries, or renewable systems may delay benefits.
- Equity gaps if rollout is uneven → benefits may cluster in better-off households or institutions without targeted safeguards.

### Path Forward

Utqiagvik's emissions profile and social determinants of health reveal a community at the frontlines of both environmental vulnerability and opportunity. Stationary combustion in buildings, diesel-based electricity generation, and heavy-duty transportation represent the most significant sources of emissions, while high asthma, diabetes, and economic insecurity highlight the need for solutions that deliver health and equity co-benefits. The strategies outlined—improving building energy efficiency, expanding renewable energy and reducing diesel dependence, and targeting heavy-duty transportation—offer the greatest potential for meaningful reductions in emissions while directly addressing the needs of populations.

The path forward should focus on phased implementation that delivers near-term benefits while building capacity for long-term transformation. Early action can prioritize deep retrofits for public facilities and rental housing, renewable energy integration into community microgrids, and pilot electrification of municipal fleets. At the same time, workforce training, tenant protections, and youth engagement programs will ensure that benefits are equitably shared and sustained. By aligning emissions reduction with improvements in health, resilience, and local economic opportunity, Utqiagvik can lead in demonstrating how Arctic communities can transition toward a more sustainable, self-determined future.

# North Slope Region, North Slope Borough



Population: 3,294

Census Tract: 2185000200

Communities: Anaktuvuk Pass, Atkasuk, Kaktovik, Nuiqsut, Point Hope, Point Lay, Wainwright

Kaktovik: By Danielle Brigida, mikimedia

The North Slope faces a unique convergence of environmental and community challenges: extremely high dependence on fossil fuels for heating and power, disproportionately high household energy burdens, and health disparities linked to housing quality and limited healthcare access. At the same time, the population is young, culturally rooted, and resilient, offering strong potential for locally driven solutions. By aligning emissions reduction strategies with the social determinants of health, the region can reduce emissions while directly improving the well-being of vulnerable communities. This roadmap focuses on opportunities to address the largest sources of emissions while strengthening equity, resilience, and economic security.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Community Energy Transition: Local Renewables + Microgrids + Fuel
2. Housing Efficiency & Electrification (Weatherization + Cold Climate Heat Pumps + Clean Heating Retrofits)
3. Workforce & Digital Equity for Clean Energy Deployment

Together, these three strategies directly target the region's largest emissions sources—stationary combustion for heat and power—while simultaneously lowering household energy costs and improving health in vulnerable housing. At the same time, workforce and digital equity investments ensure these solutions are maintained locally, creating lasting economic and social benefits for at-risk communities.

## Emissions Data Overview

Note that these emissions data are for the entire Census Area, which contains three Census Tracts.

Total Modeled Emissions: 304,205 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (94.59 %)

- Residential Sector (6.05%)
  - Electricity: 10,546.64 mt CO<sub>2</sub>e (3.47% of total)
  - Natural Gas: 1,213.22 mt CO<sub>2</sub>e (0.40 % of total)
  - Residual Fuel Oil No. 5: 6,652.40 mt CO<sub>2</sub>e (2.19% of total)
  - Wood & Wood Residuals: 0.36 mt CO<sub>2</sub>e (~0% of total)
- Commercial Sector (73.20%)
  - Distillate Fuel Oil No. 1: 4,092.25 mt CO<sub>2</sub>e (1.35% of total)
  - Natural Gas: 67,367.03 mt CO<sub>2</sub>e (22.15% of total)
  - Propane: 312.40 mt CO<sub>2</sub>e (0.10% of total)
  - Wood & Wood Residuals: 11.36 mt CO<sub>2</sub>e (~0% of total)
  - Electricity: 11,413.43 mt CO<sub>2</sub>e (3.75% of total)
- Industrial Sector
  - Distillate Fuel Oil No 1: 357.41 mt CO<sub>2</sub>e (0.12% of total)
  - Natural Gas: 185,785.35 mt CO<sub>2</sub>e (61.07% of total)

### Transportation (5.41%)

By fuel type:

- Diesel fuel: 6,665.37 mt CO<sub>2</sub>e (2.19 %)
- Motor gasoline: 9,787.54 mt CO<sub>2</sub>e (3.22 %)
- Electricity (for electric vehicles, etc.): 0.07 mt CO<sub>2</sub>e (very small)

By vehicle type (within transport):

- Trucks: 16,044.04 mt CO<sub>2</sub>e (97.51 % of transport emissions)
- Passenger vehicles: 376.13 mt CO<sub>2</sub>e (~2.29 %)
- Motorcycles: 32.82 mt CO<sub>2</sub>e (~0.20 %)
- This suggests heavy reliance on trucks/freight/mobility of goods rather than personal vehicle use.

### Electricity Generation

- Electricity consumption: 78,975.16 MWh
- Generation sources:
  - Petroleum: 69,498.14 MWh → 20,015.46 mt CO<sub>2</sub>e (91.14% of generation emissions)
  - Natural Gas: 9,477.02 MWh → 1,944.68 mt CO<sub>2</sub>e (8.86%)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- Stationary combustion is overwhelmingly dominant (94–95 %) in the region's emissions profile.
- Within stationary combustion, the industrial sector (particularly natural gas use) and commercial natural gas use are major emission drivers.
- Transportation is a much smaller slice, but heavily skewed toward diesel/truck usage.
- Electricity generation emissions are strongly dependent on petroleum (diesel/fuel oil) sources, with natural gas playing a smaller role.



## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Vulnerability:** Anticipated changes in extreme weather (11.93) suggest environmental stressors are present, though not at the most severe end nationally.
- **Disaster Loss:** Annualized disaster losses total nearly \$492,000, ranking in the 29th percentile, indicating moderate disaster vulnerability compared to the nation.
- **Air Quality & Toxics:** Diesel particulate matter exposure is negligible, but air toxics cancer risk (score of 8.00) shows some risk remains. Toxic releases and hazardous waste scores are below national averages, suggesting relatively low industrial pollution exposure.
- **Defense & Infrastructure Legacy:** Presence of formerly used defense sites signals potential residual contamination risks. Pre-1980s housing (70th percentile nationally) may bring asbestos, lead paint, or structural inefficiencies.
- **Transportation:** Proximity to high-volume roads is modest. Airports are nearby, though airport exposure is minimal on a national scale.

**Implications:** The environmental setting reflects moderate disaster vulnerability and legacies of defense and aging housing infrastructure. While direct industrial pollution is limited, risks tied to historical land use and building age could affect community health. This background underscores the importance of resilience and environmental monitoring when integrating pollution reduction goals.

### Public Health Indicators

- **Chronic Conditions:** Asthma (2.4%), cancer (0.9%), and diabetes (2.3%) rates are relatively low compared to national levels, though diabetes remains significant given elevated Indigenous risk factors.
- **Cardiovascular Risks:** High blood pressure (6.3%) is moderate, but heart disease ranks in the 62nd national percentile—an area of concern.
- **Mental Health:** Poor mental health prevalence (3.5%) is modest, though access to culturally appropriate services may be limited.
- **Life Expectancy:** Average life expectancy is 76.9 years. However, the community falls into the 65th percentile for low life expectancy, meaning it lags behind many U.S. areas.

**Implications:** Health outcomes are mixed—general chronic disease rates are low, but heart disease and life expectancy remain concerning. These disparities suggest that social and environmental pressures are influencing long-term health outcomes, which must be factored into resilience and pollution reduction planning.

### Socioeconomic Factors

- **Poverty & Inequality:** Nearly 37% of residents live below 200% of the poverty line (85th percentile nationally). Income inequality (GINI = 0.40) is moderate but notable.
- **Education & Employment:** Educational attainment is low—23% lack a high school diploma (99th percentile nationally). Unemployment is very high at 10.6% (93rd percentile nationally).
- **Housing & Costs:** Renters make up 39% of households, but housing cost burden is relatively low at 16%. Median home values are far below national averages (\$95,200). Energy burden, however, is extreme (90th percentile), reflecting high costs of heating, power, and fuel in remote Arctic communities.
- **Healthcare & Digital Access:** A striking 24.7% are uninsured (95th percentile) and 33% lack internet access (92nd percentile). Both severely restrict access to healthcare, telehealth, and education.
- **Demographics:** The community is very young—36% are under 18 (95th percentile nationally). Only 7% are over 65. Disability rates (11.1%) are close to national norms.

**Implications:** Socioeconomic disadvantage—especially education, unemployment, energy burden, and insurance gaps—creates structural barriers to health and resilience. With a young population, intergenerational poverty and limited access to resources may constrain adaptive capacity.

### Transportation Insecurity

- Access: Transportation access is limited (score of 0.22), ranking in the 63rd percentile nationally, indicating above-average barriers.
- Costs: Transportation costs are moderate (14% of household spending, 58th percentile nationally).
- Safety: Traffic fatalities occur at a rate of 1.44 per 100,000 residents, aligning with national medians.

**Implications:** While not extreme, transportation access challenges can compound isolation, limit healthcare and job access, and hinder adaptation. In a remote Arctic environment, these gaps reinforce reliance on costly fuel-based mobility.

### Intersection with Emissions Reduction Planning

- Energy Dependence: High energy burdens and reliance on expensive fuel sources highlight both vulnerability and opportunity—energy efficiency and renewable access could dramatically improve household stability.
- Socioeconomic Stressors: Poverty, unemployment, and low education rates could slow adoption of emissions reduction policies unless coupled with workforce training and affordability programs.
- Health Vulnerabilities: Elevated heart disease, mental health needs, and lower life expectancy mean pollution reduction strategies must also address co-benefits for health (e.g., cleaner heating reducing cardiovascular stress).
- Youth Population: With one-third of the population under 18, investments in community stability and preparedness intersect strongly with education, skill development, and future workforce readiness.
- Digital & Access Gaps: Limited internet and healthcare access may hinder outreach and participation in state-led emissions reduction planning unless addressed through community-specific engagement methods.



Point Hope: By Egunt07, wikimedia

## Mitigation Strategies

### Energy Transition and Efficiency

The North Slope's emissions profile is dominated by stationary combustion, particularly from industrial natural gas and residential/commercial heating with fuel oils and diesel. At the same time, households face an energy cost burden in the 90th percentile nationally, reflecting high dependence on imported fuels and extreme operating costs. Strategies here should target both system-wide emissions and household resilience:

- Local renewable deployment such as wind, solar (during summer months), and battery storage to offset diesel and natural gas generation.
- Community-scale microgrids that integrate renewables with backup diesel for reliability in Arctic conditions.
- Weatherization and efficiency retrofits in older housing stock (70th percentile pre-1980s housing) to cut heating demand, reduce respiratory stressors, and lower costs.
- Industrial efficiency measures in natural gas use, including electrification of selected processes where feasible.

Rationale: These interventions both reduce emissions and address household financial stressors, improving health outcomes tied to heating and indoor air quality.

### Transportation Decarbonization

Transportation is a smaller share of emissions (~5.4%), but is highly skewed toward diesel-fueled trucks. Mobility is central to both supply chains and community access in this remote region, where transportation access scores are below average. Strategies should improve connectivity while reducing reliance on diesel:

- Fleet electrification for light-duty vehicles in municipal and school operations, paired with renewable-powered charging stations.
- Hybrid or renewable-diesel options for freight trucks, recognizing the logistical challenges of full electrification in extreme cold.
- Community-based transport services (shared shuttles, coordinated logistics) to reduce per-capita fuel use while improving mobility.
- Airport and marine efficiency upgrades, including electrified ground support equipment and cleaner fuels for regional shipping.

Rationale: These strategies lower emissions from diesel reliance while also reducing household costs of mobility and expanding access to healthcare, jobs, and education.

### Health, Housing, and Indoor Air Quality

The region faces elevated heart disease prevalence, lower life expectancy, and substantial uninsured rates. Many homes are older and inefficient, with a significant portion built before 1980. Emissions reduction strategies that also improve health outcomes will be critical for community acceptance:

- Electrification of home heating and hot water through heat pumps designed for cold climates, reducing combustion-related indoor pollution.
- Replacement of inefficient stoves and fuel oil heaters with safer, cleaner systems.
- Retrofits for mold and moisture management to reduce asthma triggers.
- Integration of resilience hubs in schools or community centers, providing safe, clean air environments during extreme events.

Rationale: These investments simultaneously cut emissions, improve respiratory and cardiovascular health, and reduce long-term healthcare burdens, especially important in a community with limited healthcare access.

### Digital and Workforce Equity

The North Slope faces structural barriers—unemployment in the 93rd percentile, 23% without a high school diploma, and 33% lacking internet access. Emissions reduction strategies must be designed as workforce and equity opportunities, not just technical fixes:

- Training programs for renewable energy technicians, efficiency auditors, and microgrid operators, with pathways for youth given the high under-18 population share (95th percentile).
- Digital infrastructure upgrades (broadband expansion) to enable remote work, education, and telehealth, reducing both travel and emissions.
- Apprenticeships and local contracting requirements in construction and energy projects to keep jobs within the region.
- Energy cost savings reinvestment programs where efficiency savings are directed into education and workforce pipelines.

**Rationale:** By linking mitigation with job creation and education, strategies address the socioeconomic determinants driving vulnerability while building community capacity to maintain systems long-term.

### Community Resilience and Traditional Knowledge Integration

Sustainable energy planning in the North Slope must recognize Indigenous leadership, cultural practices, and the value of local knowledge. Mitigation strategies can be aligned with resilience to protect both ecosystems and livelihoods:

- Community-led planning boards to ensure strategies are culturally appropriate and locally controlled.
- Support for subsistence practices (hunting, fishing) through fuel-efficient transport equipment, storage facilities, and cold-climate innovations that reduce emissions while sustaining food security.
- Monitoring and adaptive systems to track permafrost thaw, extreme weather, and ecosystem changes, linking data to both environmental models and traditional observations.
- Low-carbon building design for community facilities that incorporate local materials and cultural design principles.

**Rationale:** This approach ties emissions reductions directly to cultural survival, food security, and long-term resilience, ensuring strategies are not seen as external impositions but as part of community self-determination.

### Improved Outcomes for Overburdened and Underserved Communities

Improved emissions reduction and health outcomes for at-risk populations in the North Slope will come from strategies that directly reduce household energy burdens, expand access to clean and affordable heat, and create stable local employment. By replacing costly diesel and fuel oil heating with renewable generation and efficiency retrofits, families will experience more predictable and lower utility costs, safer indoor air quality, and reduced risks of respiratory and cardiovascular disease. Coupled with workforce training and broadband expansion, residents will also gain new opportunities for education and income, helping to break cycles of unemployment and limited mobility that currently constrain community resilience.

These outcomes extend beyond emissions reductions; they represent tangible improvements in daily life for low-income households. Reduced reliance on expensive imported fuels frees up household income for food, healthcare, and education. Cleaner energy infrastructure ensures healthier living conditions, while local job creation reinforces economic stability. Together, these measures position at-risk communities not only as beneficiaries of emissions reduction action but as central partners in building a healthier, more resilient North Slope.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Energy Transition & Efficiency (renewables, microgrids, weatherization, industrial efficiency/ electrification)**

| Outcome             | Potential Impact                                                                                                                                                                                              | Quantitative / Qualitative Assessment                                                                                                                                        | Community Benefits                                                                                                                               |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Target stationary combustion (dominant share). Community wind/ solar + storage, building efficiency, and selective industrial electrification could abate a meaningful portion of fossil heat and generation. | High. Order-of-magnitude potential: 15–35% of area-wide emissions over 10–15 yrs if scaled (largest lever: industrial/commercial natural gas; secondary: diesel power/heat). | High. Reduces pollution near homes and facilities; ensures benefits if programs prioritize low-income households and community facilities first. |
| Energy cost savings | Weatherization + heat electrification + local generation cut fuel imports and volatility.                                                                                                                     | High. Typical 15–40% savings on building energy use after deep retrofits; microgrids can trim generation fuel by 10–25%.                                                     | High. Direct bill relief for high-burden households; frees income for essentials (food/health/education).                                        |
| Health benefits     | Cleaner indoor air (less fuel oil combustion), warmer/drier homes, fewer outages.                                                                                                                             | High. Expect fewer respiratory/cardiovascular exacerbations; improved thermal comfort and mold/ moisture control.                                                            | High. Strong co-benefits where uninsured rates and access barriers are high.                                                                     |
| Resilience          | Microgrids and weatherized stock ride through storms/ fuel supply disruptions.                                                                                                                                | High. Improves outage tolerance (hours–days), reduces emergency heating fuel dependence.                                                                                     | High. Prioritizing critical sites (clinics, schools, housing) directly protects at-risk households.                                              |
| Disbenefits / risks | Upfront costs; supply-chain/logistics to remote sites; O&M capacity; technology fit in Arctic conditions.                                                                                                     | Moderate. Risks largely manageable with local training, robust design specs, and service contracts; financial risk if savings don't meet projections.                        |                                                                                                                                                  |



### Transportation Decarbonization (public fleets, charging hubs, renewable diesel pilots, logistics coordination)

| Outcome             | Potential Impact                                                                                      | Quantitative / Qualitative Assessment                                                                                                            | Community Benefits                                                                                                            |
|---------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Smaller slice than stationary sources; biggest gains from trucks/freight and public fleets.           | Moderate. Order-of-magnitude potential: 3–8% over 10 yrs with municipal/school fleet electrification, coordinated freight, and low-carbon fuels. | Moderate–High. Public fleets serve everyone; targeted mobility options reduce inequities in access to jobs/healthcare.        |
| Energy cost savings | EVs lower per-mile energy and maintenance; freight gains depend on routes/temperature.                | Moderate. LDV fleet TCO savings often 10–30%; Arctic derates cut into range/savings—needs right-sizing and depot charging.                       | Moderate. Lower public service operating costs can stabilize local budgets; shared transit reduces household transport costs. |
| Health benefits     | Less diesel NOx/PM near homes, schools, and community hubs.                                           | Moderate. Localized air-quality gains where vehicles idle; benefits concentrated at depots and high-traffic corridors.                           | Moderate–High. Prioritize routes and sites near at-risk housing/schools to maximize benefit distribution.                     |
| Resilience          | Fewer fuel deliveries; diversified energy (local power + storage).                                    | Moderate. Depot-based charging + microgrids sustain essential mobility during fuel/supply disruptions.                                           | High (when public-facing). Keeps critical services (school, EMS) running for vulnerable residents.                            |
| Disbenefits / risks | Cold-weather performance; charger reliability; higher capex for heavy vehicles; workforce upskilling. | Moderate. Manage with cold-rated tech, heated storage, phased procurement, and technician training.                                              | Mitigation needed. Avoid concentrating chargers only in affluent areas; pair deployment with community access policies.       |



**Health, Housing & Indoor Air Quality (heat pumps for cold climate, clean replacements for oil stoves, moisture/mold retrofits, resilience hubs)**

| Outcome             | Potential Impact                                                                                    | Quantitative / Qualitative Assessment                                                                     | Community Benefits                                                                                             |
|---------------------|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Fuel-switching and envelope upgrades in older homes cut heating fuel demand.                        | Moderate–High. Home-level 20–50% fuel reductions common; community-wide impact scales with participation. | High. Prioritize high-burden, substandard housing first to maximize equity.                                    |
| Energy cost savings | Efficiency + electrification tame high heat costs and volatility.                                   | High. Typical household annual bill reductions 15–40%; deeper savings with weatherization + heat pumps.   | High. Direct relief to low-income renters/owners; design programs to protect renters from retrofit rent hikes. |
| Health benefits     | Reduced indoor combustion, better ventilation, moisture control.                                    | High. Lower asthma/COPD triggers; fewer cold-weather health incidents; improved sleep and mental health.  | High. Co-deliver with health partners for uninsured and hard-to-reach residents.                               |
| Resilience          | Resilience hubs provide clean, warm, powered shelter during outages/extremes.                       | High. Critical for youth/elders and medically vulnerable residents.                                       | High. Locating hubs at schools/community centers maximizes equitable access.                                   |
| Disbenefits / risks | Upfront costs; maintenance literacy; landlord pass-through; technology suitability in extreme cold. | Moderate. Address via incentives, performance guarantees, tenant protections, and Arctic-rated equipment. | Mitigation essential. Anti-displacement and split-incentive solutions (on-bill tariffs, weatherization-first). |



Point Lay: By Thester11 r, wikimedia

**Digital & Workforce Equity (broadband for telehealth/learning, local clean-energy training, apprenticeships, local procurement)**

| Outcome             | Potential Impact                                                                        | Quantitative / Qualitative Assessment                                                                    | Community Benefits                                                                                       |
|---------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| GHG reduction       | Indirect: enables remote work/learning; supports smart controls and O&M for microgrids. | Low–Moderate. Emissions effects are second-order but persistent (behavioral + operational).              | High. Expands access to jobs/education for low-income households; reduces travel burden.                 |
| Energy cost savings | Better building/utility data, remote diagnostics, and demand response.                  | Moderate. 5–15% operational savings plausible in public/commercial stock with controls/analytics.        | High. Savings at public facilities free budget for community services; workforce pathways raise incomes. |
| Health benefits     | Telehealth access; mental health services; reduced travel barriers.                     | Moderate. Measurable access improvements where uninsured and access gaps are high.                       | High. Directly targets barriers faced by at-risk residents (connectivity, schedules, distance).          |
| Resilience          | Communications continuity; local technicians to maintain energy systems.                | Moderate–High. Faster outage response; local capacity reduces downtime and costs.                        | High. Builds lasting local capability rather than external dependence.                                   |
| Disbenefits / risks | Program uptake, affordability of service/devices; training pipeline lead time.          | Low–Moderate. Manage via subsidies, device lending, paid apprenticeships, and guaranteed job placements. | Mitigation needed. Ensure low-income tiers and device access; align training with actual projects.       |



Point Hope: By Egunt07 r, wikimedia



### Community Resilience & Traditional Knowledge Integration (community boards, subsistence-support measures, monitoring, low-carbon civic buildings)

| Outcome             | Potential Impact                                                                                   | Quantitative / Qualitative Assessment                                                                       | Community Benefits                                                                                      |
|---------------------|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| GHG reduction       | Indirect but foundational—governance and design choices steer all projects.                        | Low–Moderate. Hard to quantify standalone; high leverage through better siting/design and community buy-in. | High. Ensures benefits flow to at-risk households and respect cultural practices.                       |
| Energy cost savings | Better project fit reduces lifecycle costs and failure rates.                                      | Moderate. Avoided rework and higher uptime reduce community expenses.                                       | High. Community-led prioritization directs savings to those most burdened.                              |
| Health benefits     | Protects food security, supports culturally appropriate spaces, reduces stress during transitions. | Moderate–High. Strong co-benefits for mental/behavioral health and nutrition.                               | High. Centers needs of vulnerable groups (youth, elders, subsistence households).                       |
| Resilience          | Aligns with permafrost/extreme-weather realities; improves adaptive capacity.                      | High. Better hazard monitoring, durable designs, and culturally anchored plans.                             | High. Reduces disparate harms from disasters and supply disruptions.                                    |
| Disbenefits / risks | Longer planning cycles; coordination costs; risk of consultation without power-sharing.            | Low–Moderate. Address by formal authority, timelines, and funding for participation.                        | Mitigation essential. Resource community participation so it's not burdensome to low-income households. |



Anaktuvuk Pass: By 807th Medical Command, wikimedia

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy burden → More affordable heating and electricity bills, freeing income for essentials like food, healthcare, and education.
- Improved health outcomes → Cleaner indoor air, better housing quality, and reduced exposure to combustion-related pollutants lower respiratory and cardiovascular risks.
- Job creation and skills development → Local training and employment in renewable energy, efficiency retrofits, and microgrid operations expand opportunities, especially for young residents.
- Community resilience → Weatherized homes, resilience hubs, and microgrids increase safety and security during extreme weather and supply disruptions.
- Cultural and food security support → Traditional knowledge integration and cleaner, more efficient mobility help sustain subsistence practices and local livelihoods.
- Access and equity improvements → Broadband and telehealth expansion reduce barriers to healthcare and education, particularly for uninsured and remote households.

Potential disbenefits if not designed equitably:

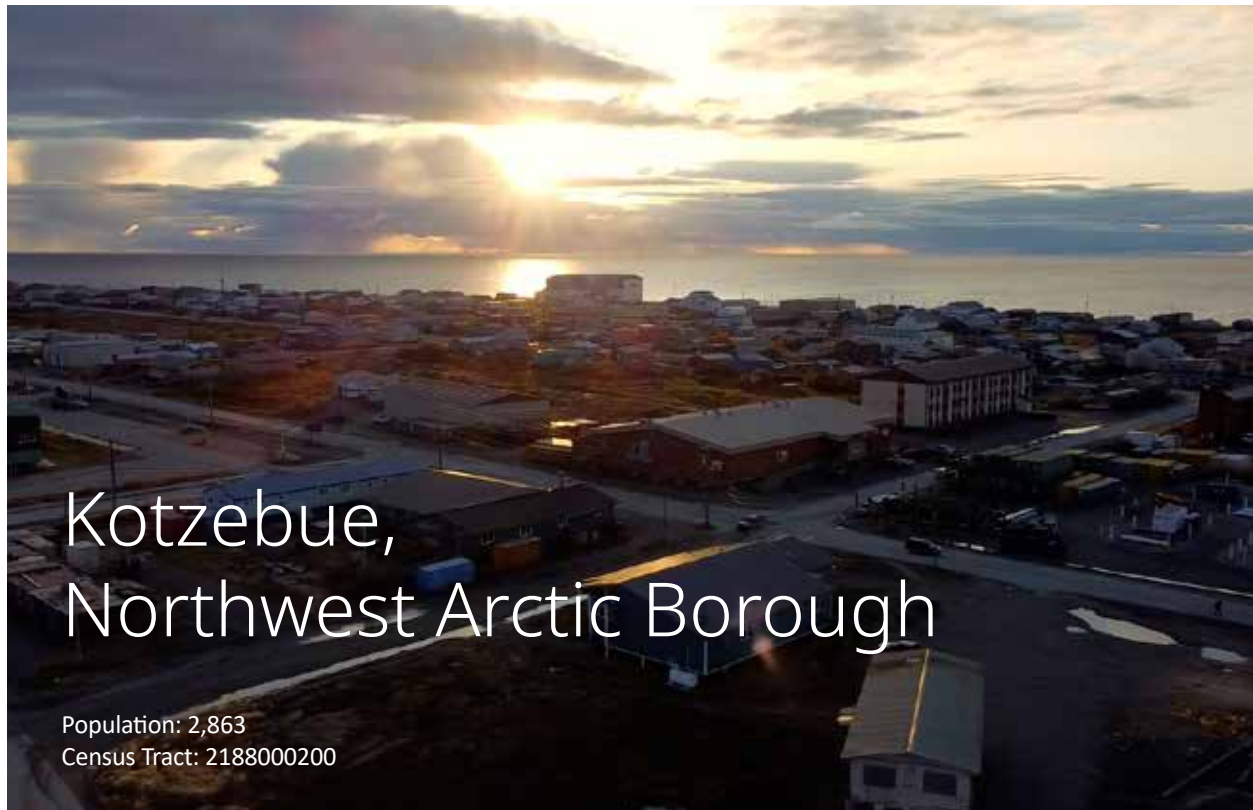
- High upfront costs → Without careful design, programs could increase financial strain or shift costs to low-income residents.
- Technology performance gaps → Cold-climate conditions may reduce the reliability of certain technologies (e.g., EVs, heat pumps) if not properly adapted.
- Housing displacement risk → Efficiency upgrades in rental housing could raise rents if protections are not in place, potentially displacing vulnerable tenants.
- Unequal access to benefits → If not targeted, wealthier or more connected households may capture early program benefits, widening inequities.
- Program complexity and capacity limits → Local workforce and institutional capacity constraints could slow implementation or reduce program effectiveness.
- Cultural mismatch → Strategies designed without meaningful community input may fail to align with Indigenous knowledge, traditions, and priorities.

### Path Forward

Moving forward, North Slope emissions reduction strategies should prioritize interventions that deliver the greatest combined impact on emissions reduction and outcomes for vulnerable communities. Community-scale energy transition, housing efficiency and electrification, and investments in workforce and digital equity form the foundation for reducing emissions, lowering energy costs, and improving health and resilience. Successful implementation will require targeted funding mechanisms, culturally appropriate engagement, and a phased approach that pairs immediate household relief with long-term infrastructure transformation. By centering equity and local leadership, the North Slope can become a model for how Arctic and rural communities turn the challenge of emissions reduction into an opportunity for healthier, more sustainable futures.



Atkasuk: By Thester11, Wikimedia



# Kotzebue, Northwest Arctic Borough

Population: 2,863  
Census Tract: 2188000200

Kotzebue, located within the Northwest Arctic Borough of Alaska, is a remote community at the front line of both environmental change and health inequities. With a population of just under 3,000 residents, the community experiences a unique blend of challenges that stem from its geographic isolation, reliance on imported fuels, and socioeconomic disparities. At the same time, Kotzebue demonstrates significant resilience through strong cultural ties, a youthful population, and existing renewable energy initiatives.

This roadmap builds on two essential foundations: the social determinants of health that shape wellbeing in the region, and the community's emissions profile that highlights where local sources of emissions are most concentrated. Together, these perspectives provide a framework for identifying strategies that not only reduce emissions but also improve health, strengthen resilience, and advance equity.

Because at-risk communities bear disproportionate burdens—from high energy costs and housing insecurity to elevated rates of asthma, diabetes, and mental health stressors—emissions reduction strategies must be designed with equity at their core. The following analysis outlines how targeted mitigation actions can deliver cross-cutting benefits: lowering emissions, reducing household energy burdens, protecting public health, and building systems that support long-term community vitality.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Residential & Building Energy Transition
2. Home Weatherization & Retrofit Acceleration
3. Transportation Efficiency & Electrification

Together, these strategies align emissions reductions with local health priorities, economic equity, and infrastructure resilience, ensuring that emissions reduction planning is responsive to the unique needs of the Northwest Arctic Borough.

## Emissions Data Overview

Total Modeled Emissions: 28,830 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (65.01 %)

- Residential Sector (44.65%)
  - Residual Fuel Oil No. 5: 11,317.16 mt CO<sub>2</sub>e (39.25% of total)
  - Electricity: 1,534.60 mt CO<sub>2</sub>e (5.32% of total)
  - Wood & Wood Residuals: 21.74 mt CO<sub>2</sub>e (0.08% of total)
- Commercial Sector (20.36%)
  - Distillate Fuel Oil No. 1: 2,768.07 mt CO<sub>2</sub>e (9.6% of total)
  - Electricity: 2,883.32 mt CO<sub>2</sub>e (10% of total)
  - Propane: 211.31 mt CO<sub>2</sub>e (0.73% of total)
  - Wood & Wood Residuals: 7.66 mt CO<sub>2</sub>e (0.03% of total)
- Industrial Sector: 0%

### Transportation (34.99%)

By fuel type:

- Motor gasoline: 7,345.08 mt CO<sub>2</sub>e (25.48 %)
- Diesel fuel: 2,741.12 mt CO<sub>2</sub>e (9.51%)
- Electricity (for electric vehicles, etc.): 0.07 mt CO<sub>2</sub>e (negligible)

By vehicle type (within transport):

- Trucks/ heavy vehicle types: 9,639.81 mt CO<sub>2</sub>e (95.57% of transportation emissions)
- Passenger Vehicles: 433.47 mt CO<sub>2</sub>e (4.3 %)
- Motorcycle: 12.99 mt CO<sub>2</sub>e (0.13 %)

### Electricity Generation

- Electricity usage & fuel mix:
  - Total electricity used: 19,667 MWh
  - Diesel-based: 15,340.26 MWh → 4,418.00 mt CO<sub>2</sub>e (100 % of generation emissions)
  - Wind: 3,933.40 MWh → 0.00 mt CO<sub>2</sub>e
  - Solar: 393.34 MWh → 0.00 mt CO<sub>2</sub>e
- Interpretation: All of the direct GHG emissions from electricity generation in Kotzebue derive from diesel combustion; wind and solar contribute generation without direct GHG emissions (in this inventory)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- Dominant role of stationary combustion: Over 65 % of emissions come from heating, building energy use, and facility-based fuel combustion.
- Heavy reliance on heavy fuel oil: Residual Fuel Oil No. 5 is the largest single fuel source, especially in residential buildings.
- Transportation is also a significant contributor: Nearly one third of emissions come from mobile sources, dominated by heavy trucks.
- Electricity is diesel-based: All local generation emissions originate from diesel; renewables are present (wind, solar) but currently non-emitting in this inventory.



## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Risk:** Anticipated changes in extreme weather are moderately high (36.36 percentile), indicating vulnerability to environmental shifts.
- **Disaster Risk:** Annualized disaster loss percentile is relatively low nationally (8.52), but costs are non-negligible at ~\$116K annually.
- **Pollution Exposure:** Diesel particulate matter (0.01) is low, but air toxics cancer risk is significant (10.00 percentile).
- **Hazardous Site Exposure:** Moderate proximity to hazardous sites (48.30 percentile) but no Superfund or RMP facilities.
- **Housing Risks:** Pre-1980s housing (34.55% of stock) suggests exposure to older infrastructure challenges.
- **Flood Risk:** No properties are currently flagged for flood risk.

Implications: Kotzebue's relatively clean air and low toxic release exposures are positive, but moderate hazardous site proximity, aging housing stock, and increasing extreme weather risks suggest vulnerabilities. These conditions heighten the need for resilient infrastructure and may influence how emissions reduction strategies are prioritized for disaster preparedness and health protection.

### Public Health Indicators

- **Asthma:** Prevalence is extremely high (11.6% of population, 100th percentile nationally).
- **Chronic Disease Burden:** High rates of diabetes (10%, 95th percentile), hypertension (30.3%, 88th percentile), and cancer prevalence (4.6%, 77th percentile).
- **Mental Health:** Poor mental health prevalence is significant (16.3%, 100th percentile).
- **Cardiovascular Risks:** Heart disease risk sits around the national average (51st percentile).
- **Life Expectancy:** At 79.9 years, life expectancy is fairly strong, though low expectancy ranks at 35th percentile.

Implications: Chronic disease prevalence and high asthma and mental health burdens present major public health challenges. These conditions may be exacerbated by environmental pollution, housing quality, and economic stressors. Health vulnerabilities will strongly shape how Kotzebue engages with emissions reduction, as strategies that improve air quality and reduce environmental stressors may directly reduce disease burden.

### Socioeconomic Factors

- **Poverty:** About 30% live below 200% of the federal poverty line (71st percentile nationally).
- **Education:** 8.3% lack a high school diploma (68th percentile).
- **Employment:** Unemployment is moderate at 3.9% (47th percentile).
- **Housing:** High renter occupancy (59.9%, 88th percentile) and moderate housing cost burden (17.9%).
- **Insurance Coverage:** Nearly 25% are uninsured (95th percentile).
- **Digital Divide:** 14.6% lack internet access (59th percentile).
- **Energy Burden:** At 4% of annual income, this is relatively high (73rd percentile).
- **Demographics:** A youthful population (31% under 18, 88th percentile) alongside a growing elder population (6.9% over 65, 95th percentile).

Implications: High poverty, low insurance coverage, and energy burdens create economic and health insecurities that limit resilience. A youthful population signals long-term opportunities, but the high uninsured rate and renter dominance indicate systemic inequities. These factors may constrain residents' ability to adopt or benefit from emissions reduction measures unless policies address affordability and access.

### Transportation Insecurity

- Access: Transportation access score is low (-0.40, 30th percentile nationally).
- Affordability: Transportation cost burden is minimal (0.11, 25th percentile).
- Safety: Traffic fatality rates are moderate (2.1 per 100,000, 60th percentile).

**Implications:** Limited transportation access restricts mobility and access to health care, jobs, and services, especially given the geographic isolation of Kotzebue. While cost burdens are relatively low, safety and access issues suggest transportation resilience is fragile. This dynamic will influence emissions reduction strategies, as transitions to cleaner systems must account for accessibility, geographic isolation, and safety concerns.

### Intersection with Emissions Reduction Planning

- Health and Vulnerability: High asthma and chronic disease prevalence suggest that reducing emissions (e.g., diesel, particulates) will yield significant co-benefits for health.
- Economic and Equity Barriers: High poverty, uninsured rates, and energy burdens imply that sustainability policies must integrate affordability and equity to succeed.
- Infrastructure and Resilience: Aging housing, hazardous site exposure, and transportation challenges indicate that resilience-building should align with pollution reduction.
- Youth and Elders: A large youth population and growing elder group both require special consideration for sustainability-related planning, particularly regarding energy, health care, and mobility.

**Overall Implication:** Kotzebue's social determinants of health highlight significant vulnerabilities but also areas where emissions reduction strategies could yield strong health and equity benefits if designed inclusively. Addressing health, economic inequality, and infrastructure resilience will be key for aligning local needs with the State's sustainable energy action plan.



## Mitigation Strategies

### Residential & Building Energy Transition

Kotzebue's emissions profile shows that residential buildings are the single largest source of emissions (over 44% of total). The heavy reliance on Residual Fuel Oil No. 5 and distillate fuels creates both emissions and health burdens (asthma, cardiovascular disease, mental health stress). Many homes are also older (pre-1980s housing stock at 34.55%), which exacerbates energy inefficiency and fuel dependency.

Strategies:

- Electrification of heating systems: Where feasible, support adoption of air source heat pumps or electric boilers, combined with renewable electricity.
- Community-scale heating solutions: District heating powered by renewables (e.g., biomass from local sources or expanded wind-diesel hybrid systems).
- Fuel-switching incentives: Programs to replace high-sulfur residual fuel oil with cleaner alternatives during the transition.

Rationale: These measures would directly reduce emissions while lowering energy burdens and improving indoor environments, addressing asthma and chronic illness risk factors.

### Renewable & Resilient Energy Generation

Electricity in Kotzebue is still predominantly diesel-based, despite existing wind and solar generation capacity. While renewables already provide clean MWhs, they offset only a fraction of total generation. Expanding renewables will not only reduce emissions but also strengthen community resilience to fuel price volatility and extreme weather disruptions.

Strategies:

- Expand wind and solar penetration: Increase renewable share beyond current ~20% (wind + solar), with investments in storage to stabilize supply.
- Battery and microgrid systems: Enable higher renewable integration and provide backup during outages or storms.
- Community-scale solar programs: Rooftop and shared solar to allow renters (nearly 60% of households) to participate.
- Integrate efficiency with renewables: Combine renewable expansion with demand-side management and efficiency programs for maximum impact.

Rationale: Cleaner electricity supports electrification in heating and transport, lowers diesel dependence, and enhances resilience for vulnerable households.

### Home Weatherization & Retrofit Acceleration

The data for Kotzebue shows an aging housing stock, including substantial pre-1980 homes. Weatherization is a high-impact, near-term strategy to cut heating demand, lower household energy burdens, and improve indoor air quality—especially important given very high asthma prevalence and elevated energy burden indicators.

Strategies:

- Whole-home weatherization packages: Air sealing; attic/wall/floor insulation; targeted window/door upgrades; and distribution improvements (duct/pipe insulation) to reduce heat loss.
- Ventilation + moisture control: Install/upgrade mechanical ventilation as needed and address moisture pathways to protect indoor air quality and building durability in cold, tight homes.
- Health-prioritized retrofits: Prioritize homes with high asthma/chronic disease risk, elders, and highest energy burdens for first-round upgrades and wraparound support.
- Renter-inclusive delivery models: Pair incentives with landlord agreements/tenant protections so weatherization benefits reach renters and don't translate into rent increases.

**Rationale:** Weatherization commonly reduces space-heating loads substantially in cold climates, directly lowering fuel use and emissions while improving thermal comfort, indoor air quality, and resilience during extreme cold and supply disruptions.

### Health & Equity-Centered Environmental Adaptation

Given the high prevalence of asthma (100th percentile), diabetes, and poor mental health, sustainability strategies must explicitly link pollution reduction to public health benefits and equity. Economic stressors (high poverty, uninsured rate, high energy burden) mean that cost-sharing and subsidies are essential.

Strategies:

- Health-focused energy upgrades: Prioritize weatherization and clean heating for households with high asthma, chronic disease, or seniors.
- Subsidy and incentive programs: Cover upfront costs for low-income renters and homeowners to ensure equitable participation.
- Community health-energy programs: Integrate local health providers in energy and housing programs to track and amplify co-benefits (e.g., reduced ER visits for asthma).
- Mental health and resilience planning: Pair sustainability investments with community wellness programs to address environment-related stress and anxiety.

**Rationale:** By aligning pollution reduction with tangible health improvements, sustainability action becomes directly relevant to everyday wellbeing, ensuring stronger community support.

### Waste, Materials, and Local Food/Energy Systems (Emerging)

Although waste and agriculture currently register no recorded emissions in the inventory, Kotzebue's remote location means that material imports and waste handling carry hidden emissions and resilience risks. Building local circular systems can support both emissions reduction and health goals.

Strategies:

- Local biomass utilization: Explore sustainable harvest of local residues for heating or biofuel as a diesel substitute.
- Food-energy nexus investments: Support local food systems (greenhouses powered by renewable heat/electricity) to reduce imports and improve nutrition.
- Waste reduction and reuse: Encourage composting, recycling, and waste-to-energy pilots that reduce transport and landfill reliance.

**Rationale:** These measures provide co-benefits—lowering import reliance, improving food security, and enhancing resilience—while creating local jobs and reducing indirect emissions.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes for at-risk communities in Kotzebue will come from strategies that directly reduce the disproportionate burdens these communities face in energy, health, and economic resilience. By targeting high-cost, high-pollution fuels such as residual oil and diesel, mitigation strategies can reduce exposure to pollutants linked to asthma, cardiovascular disease, and mental health challenges—conditions that are already elevated in the region. Expanding access to affordable clean energy, and weatherized housing will lower household costs, reduce health stressors, and free resources for food, education, and wellbeing.

Equally important, inclusive design ensures that vulnerable groups—including renters, low-income households, and elders—can fully participate in and benefit from the transition. Subsidy programs, community-scale renewables, and health-centered housing retrofits create opportunities for shared economic benefits while reinforcing cultural and social resilience. In this way, sustainability planning becomes more than an emissions reduction exercise; it becomes a pathway to advance equity, improve quality of life, and support the long-term vitality of Indigenous and at-risk populations in the Northwest Arctic Borough.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Residential & Building Energy Transition (heat pumps/electric boilers, community/district heat, fuel-switching)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                     | Community Benefits                                                                                                            |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Targets the largest slice of community emissions (residential + a share of commercial). Order-of-magnitude: actionable potential in the tens of percent of total community emissions if retrofits + fuel-switching scale. | High – Renters, low-income households, elders benefit from lower energy use; prioritize high-burden homes first.              |
| Energy cost savings | High             | Weatherization commonly cuts space-heating loads 20–40% in cold-climate stock; electrification paired with efficiency can further reduce delivered fuel purchases.                                                        | High – Lowers energy burden for households with the least ability to pay.                                                     |
| Health benefits     | High             | Cleaner indoor air (less oil/diesel combustion), better thermal comfort; aligns with high asthma/mental-health burden.                                                                                                    | High – Directly addresses disproportionate health burdens in at-risk homes.                                                   |
| Resilience          | High             | Diversified heating (district heat / electric + storage) improves reliability during supply disruptions/extreme cold.                                                                                                     | High – Stabilizes comfort and safety for at-risk residents.                                                                   |
| Disbenefits / Risks | Moderate         | Upfront costs; cold-climate heat-pump performance/sizing; contractor capacity; split-incentives in rentals; fuel-price volatility during transition.                                                                      | High (if unmanaged) – Ensure no rate or rent increases displace at-risk communities; pair incentives with tenant protections. |

**Renewable & Resilient Energy Generation (expand wind/solar, batteries, microgrid optimization, demand response)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                   | Community Benefits                                                                                   |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Community generation is currently diesel-heavy; additional renewables + storage can displace most generation-related emissions over time and enable building/transport electrification. | High – System-level benefits flow to everyone; design tariffs so low-income customers share savings. |
| Energy cost savings | Moderate–High    | Reduces diesel purchases and price exposure; savings grow as penetration and storage increase. Early years may have modest net savings after capital recovery.                          | High – Shield at-risk residents from fuel spikes; consider lifeline rates/ community solar shares.   |
| Health benefits     | Moderate         | Less local diesel generation → lower local pollution exposure; indirect health gains via cheaper, cleaner power enabling electrified heat/transport.                                    | Moderate–High – Benefits broaden if paired with targeted electrification for high-burden households. |

|                     |              |                                                                                                                                     |                                                                                  |
|---------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Resilience          | High         | Storage + microgrid enhance outage ride-through, support critical facilities (clinics, shelters), and reduce supply-chain risk.     | High – Prioritize circuits serving at-risk neighborhoods and essential services. |
| Disbenefits / Risks | Low–Moderate | Capital intensity; O&M in harsh climate; integration challenges; potential near-term rate impacts without thoughtful cost recovery. | Moderate – Mitigate with grants, phased deployment, and bill protections.        |

### Home Weatherization & Retrofit Acceleration

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                       | Community Benefits                                                                                                                         |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Targets the largest slice of community emissions (residential is ~44.65% of total; heavy reliance on residual fuel oil). Weatherization reduces heating demand, cutting combustion emissions directly; scale-dependent but can be “high” if deployment reaches a meaningful share of homes. | High – Prioritize high-burden households first (low-income, elders, medically vulnerable).                                                 |
| Energy cost savings | High             | Weatherization commonly cuts space-heating loads ~20–40% in cold-climate housing stock, reducing delivered fuel purchases.                                                                                                                                                                  | High – Lowers energy burden (energy burden ~4% and relatively high nationally).                                                            |
| Health benefits     | High             | Improved indoor air quality and thermal comfort; reduces exposure from in-home oil combustion and helps address very high asthma prevalence.                                                                                                                                                | High – Direct health benefits for at-risk homes (asthma + chronic disease burdens).                                                        |
| Resilience          | High             | Tighter building envelopes improve safety/comfort during extreme cold and supply disruptions; reduces dependence on imported fuel.                                                                                                                                                          | High – Stabilizes comfort/safety for elders, children, and medically vulnerable households during disruptions.                             |
| Disbenefits / Risks | Moderate         | Upfront costs; contractor capacity; quality control; split incentives (high renter share); risk of rent increases if protections aren’t in place.                                                                                                                                           | High (if unmanaged) – Pair incentives with tenant protections / landlord agreements so renters benefit and displacement risk is minimized. |



**Health & Equity-Centered Environmental Programs (health-prioritized retrofits, subsidies, bill protections, data partnerships with clinics, resilience hubs)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                          | Community Benefits                                                                 |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Not a direct abatement lever, but accelerates uptake of high-impact measures (retrofits/electrification) by removing cost and access barriers. | Very High – By design, channels benefits first to at-risk households.              |
| Energy cost savings | High             | Targeted incentives + bill protections can immediately lower bills for the most burdened households.                                           | Very High – Direct relief and protections against energy insecurity.               |
| Health benefits     | High             | Fewer indoor pollutants, improved thermal comfort, and reduced stress; ties sustainability to tangible health outcomes.                        | Very High – Aligns with elevated asthma, diabetes, and mental-health prevalence.   |
| Resilience          | High             | Resilience hubs, backup power for clinics/shelters, and medically-necessary equipment support cut outage harms.                                | Very High – Protects the most vulnerable during extreme events.                    |
| Disbenefits / Risks | Low              | Program complexity; administrative burden; need for strong outreach/trust.                                                                     | Moderate – Use community navigators, simple applications, and landlord agreements. |

**Waste, Materials, and Local Food/Energy Systems (Emerging) (local biomass heat pilots, greenhouse/food systems tied to renewables, reduce transport needs, composting/reuse)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                      | Community Benefits                                                                          |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate     | Inventory shows little from these sectors now; indirect reductions via less freight, substituted diesel heat, and avoided waste transport. | Moderate – Benefits from lower food/energy import costs accrue to all; design access first. |
| Energy cost savings | Moderate         | Local biomass/renewable heat can displace some diesel; food system investments reduce reliance on freighted goods.                         | Moderate–High – Improves affordability and nutrition for cost-burdened households.          |
| Health benefits     | Moderate         | Better nutrition access; fewer combustion sources if designed cleanly; community co-benefits.                                              | Moderate – Pair with outreach to maximize uptake.                                           |
| Resilience          | High             | More local heat/food capacity reduces vulnerability to supply chain disruptions and extreme weather.                                       | High – Strong buffer for remote households.                                                 |
| Disbenefits / Risks | Low–Moderate     | Biomass sustainability/air-quality controls; small scale economics; O&M capacity.                                                          | Moderate – Require modern controls, sustainable sourcing, and workforce training.           |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy costs: Reduced heating fuel use and electricity bills ease energy burdens for low-income households.
- Health improvements: Cleaner indoor air and reduced diesel exposure lessen asthma, cardiovascular disease, and stress impacts.
- Equitable access to clean energy: Community-scale programs (shared solar, district heat) ensure renters and low-income families share in benefits.
- Improved resilience: Weatherized homes, renewable-powered microgrids, and resilient transport protect vulnerable groups during extreme weather or supply disruptions.
- Job creation and skills development: Local retrofit and renewable energy projects create employment pathways that can be prioritized for local and Indigenous workers.
- Community empowerment: Programs designed with health and equity priorities strengthen trust, cultural vitality, and self-determination.

Potential disbenefits if not designed equitably:

- Upfront cost and affordability challenges: Without subsidies, low-income households risk being excluded or left behind.
- Split incentives in rental housing: Renters may not benefit from efficiency upgrades if landlords pass through costs or capture savings.
- Technology performance risks: Cold-climate challenges (e.g., heat pump efficiency) could undermine adoption if not carefully addressed.
- Equity in infrastructure placement: Microgrid assets, and resilience hubs could bypass vulnerable areas without intentional siting.
- Administrative burden: Complex programs may deter participation among those with limited internet access or bureaucratic capacity.
- Unintended displacement or cost shifts: Retrofit programs could increase rents, or utility investments could raise rates if protections aren't in place.





## Path Forward

Kotzebue's emissions profile and social determinants of health tell a clear story: the greatest opportunities for meaningful emissions reduction action lie in reducing dependence on imported diesel and residual fuel oil, improving the efficiency and resilience of homes, and expanding renewable energy generation. At the same time, the community's elevated burden of chronic disease, high energy costs, and economic inequities underscore the need for strategies that deliver not only emissions reductions but also tangible health and equity benefits.

The path forward requires three interlinked priorities:

1. Transform residential and community energy systems through clean heating, and district-scale solutions that reduce household costs and improve health.
2. Expand renewable and resilient electricity generation with storage and microgrids that stabilize supply and reduce diesel dependence.
3. Embed health and equity in every investment, ensuring that low-income households, renters, elders, and Indigenous residents are not only protected but prioritized.

Moving ahead, implementation should be anchored in inclusive engagement, partnerships with health and housing providers, and funding strategies that protect vulnerable households from cost burdens. Pilot projects in housing retrofits, fleet electrification, and microgrid expansion can serve as early wins, building local capacity and community trust. Over time, scaling these initiatives will deliver cumulative reductions in emissions while strengthening the foundations of community health and resilience.

Kotzebue is already a leader in renewable integration in the Arctic. By aligning energy and pollution reduction strategies with health equity and cultural resilience, the community can continue to serve as a model for other rural and Indigenous regions working to strengthen wellbeing and address social and environmental challenges.



# Northwest Arctic Region, Northwest Arctic Borough

Population: 4,505

Census Tract: 2188000100

Communities: Ambler, Buckland, Deering, Kiana, Kivalina, Kobuk, Kotzebue, Noatak, Noorvik, Selawik

The Northwest Arctic region faces a unique convergence of challenges and opportunities at the intersection of environmental, health, and community well-being. As one of the most remote regions in Alaska, the region depends heavily on imported petroleum fuels for heating, electricity, and transportation, resulting in some of the highest household energy and transportation cost burdens in the nation. At the same time, local health indicators—including high heart disease prevalence and reduced life expectancy—underscore the urgency of reducing exposure to pollution and creating healthier living environments. Social and economic determinants, such as elevated poverty and unemployment, further highlight the need for strategies that deliver not only emissions reductions but also affordability, resilience, and equity.

In this context, sustainable energy planning cannot be separated from broader goals of community resilience and cultural survival. By centering decision-making within the community, sustainability actions can create tangible benefits—lower household costs, improved health, and greater energy security—while also building local capacity and ownership of the transition. The strategies that follow outline a pathway for the Northwest Arctic to reduce emissions in ways that are equitable, community-driven, and aligned with long-term resilience.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Transitioning Residential and Community Heating Away from Fuel Oil
2. Scaling Community Renewable Electricity with Storage
3. Electrifying Public Fleets and Improving Transport Efficiency

The top three strategies—(1) heating transition, (2) renewable electricity expansion, and (3) transport electrification—directly target the area's largest emissions sources while also addressing household cost burdens, health disparities, and community resilience. Each of these provides a strong platform for leadership, ensuring solutions are community-driven and benefits flow directly to those most impacted.

## Emissions Data Overview

Note that these data is for the entire Census Area, which contains two Census Tracts.

Total Modeled Emissions: 61,911 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (60.06 %)

- Residential Sector (39.12 % of total)
  - Residual Fuel Oil No. 5: 20,511.57 mt CO<sub>2</sub>e (33.13% of total)
  - Electricity: 3,601.67 mt CO<sub>2</sub>e (5.82% of total)
  - Natural Gas: 34.66 mt CO<sub>2</sub>e (0.06 % of total)
  - Wood & Wood Residuals: 72.35 mt CO<sub>2</sub>e (0.12% of total)
- Commercial Sector (73.20%)
  - Distillate Fuel Oil No. 1: 6,616.26mt CO<sub>2</sub>e (10.69% of total)
  - Propane: 505.08 mt CO<sub>2</sub>e (0.82% of total)
  - Electricity: 5,824.57 mt CO<sub>2</sub>e (9.41% of total)
  - Wood & Wood Residuals: 18.36 mt CO<sub>2</sub>e (0.03% of total)
- Industrial Sector: No emissions modeled in this dataset.

### Transportation (5.41%)

By fuel type

- Motor Gasoline: 18,006.33 mt CO<sub>2</sub>e (29.08 %)
- Diesel Fuel: 6,719.80 mt CO<sub>2</sub>e (10.85 %)
- Electricity (for EVs or electric vehicles): 0.21 mt CO<sub>2</sub>e (negligible share)

By vehicle type

- Trucks: 23,631.82 mt CO<sub>2</sub>e → (95.57 % of transportation emissions)
- Passenger vehicles: 1,062.67 mt CO<sub>2</sub>e (4.30 %)
- Motorcycles: 31.85 mt CO<sub>2</sub>e (0.13 %)

### Electricity Generation

- Electricity consumption: 78,975.16 MWh
- Generation sources:
  - Petroleum: 9,426.46 mt CO<sub>2</sub>e (100 % of electricity generation emissions)
  - Wind: 2,463.60 MWh generated, but associated emissions = 0 mt CO<sub>2</sub>e (i.e. no direct emissions)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- The largest share of emissions is from stationary combustion, primarily in the residential sector using residual fuel oil No. 5.
- Transportation is the second major source, especially from heavy trucks burning gasoline and diesel.
- Electricity generation contributes meaningfully, all from petroleum combustion, though wind adds some zero-emissions generation.
- This paints a picture of a community heavily dependent on fossil fuels for heat, power, and transport — with limited diversification into lower-carbon fuels.



## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Change (15.34 index)**  
The region is experiencing notable changes in extreme weather, which reflects the Arctic's heightened vulnerability to environmental instability.
- **Annualized Disaster Loss (\$194,068.16, 11.93 national percentile)**  
While losses are relatively low compared to national averages, localized impacts could be severe due to remoteness and high costs of recovery.
- **Air Quality & Toxics**  
Diesel PM exposure is minimal (0.00), but toxic air releases (39th percentile) and air toxics cancer risk (9.00 index) are present.
- **Hazardous Sites**  
No significant hazardous waste or Superfund sites are nearby, but the presence of Formerly Used Defense Sites (FUDS) could carry legacy contamination risks.
- **Housing & Infrastructure Risks**  
Pre-1980 housing is moderately high (40.41 units, 58th percentile), which can mean exposure to outdated materials and higher maintenance costs.

Implications: Environmental conditions show relatively low current industrial risk but high vulnerability to extreme weather events and legacy contamination. These factors increase reliance on resilient infrastructure and highlight the importance of environmental monitoring in planning.

### Public Health Indicators

- **Asthma (3.26%, 27th percentile) and Cancer (1.09%, 10th percentile)**  
Both are below national averages, suggesting limited current respiratory or cancer burden.
- **Diabetes (3.43%, 39th percentile) and High Blood Pressure (8.98%, 19th percentile)**  
Chronic disease prevalence is significant but not extreme, with diabetes being a concern given high-cost care needs in remote regions.
- **Poor Mental Health (4.73%, 31st percentile)**  
Mental health prevalence is moderate, though access to culturally responsive care may be limited.
- **Heart Disease (90th percentile)**  
This is the most alarming health indicator, suggesting major cardiovascular health disparities in the region.
- **Life Expectancy (75.09 years, low expectancy at 79th percentile)**  
Residents live shorter lives compared to national averages, reflecting structural inequities.

Implications: Health outcomes are strained by high heart disease prevalence and reduced life expectancy, compounded by challenges in healthcare access. These conditions make community resilience and preventive health measures critical when considering new burdens, such as pollution or environmental stressors.

### Socioeconomic Factors

- **Poverty (60.87%, 97th percentile)**  
More than half the population lives below 200% of the federal poverty line—among the highest nationally.
- **Education (21.5% with no HS diploma, 99th percentile)**  
Educational attainment is very low, limiting employment options and upward mobility.



- **Unemployment (14.6%, 98th percentile)**  
Extremely high joblessness worsens economic hardship and reduces household stability.
- **Housing Costs & Values**  
Housing cost burden is moderate (19.7%), but median home value is very low (\$95,900, 15th percentile), reflecting limited asset-building potential.
- **Insurance & Access**  
High uninsured rates (22%, 89th percentile) limit healthcare access. Internet access is also poor (29% without, 88th percentile).
- **Energy Burden (9%, 99th percentile)**  
One of the highest in the nation—energy costs consume disproportionate income shares.
- **Demographics**  
The community is very young (39% under 17, 98th percentile), while elders make up only 8.25% of the population. Disabilities are moderate (11%).  
Implications: Severe socioeconomic stressors—especially poverty, unemployment, high energy burden, and educational gaps—shape nearly every other determinant of health. These conditions make cost-sensitive, equity-focused interventions essential.

### Transportation Insecurity

- **Access Score (-0.01, 42nd percentile)**  
Transportation access is average but complicated by geographic remoteness and limited modes of travel.
- **Transportation Cost Burden (0.20, 92nd percentile)**  
Transportation consumes a very high portion of household budgets, driven by distance, fuel, and logistics.
- **Traffic Safety (1.95 deaths per 100,000, 58th percentile)**  
Traffic fatalities are moderate compared to national averages.  
Implications: Transportation is a significant barrier, not because of direct safety issues but due to the extreme costs of mobility. This reduces access to healthcare, education, and employment, and increases reliance on costly air travel and fuel-intensive systems.

### Intersection with Emissions Reduction Planning

The social determinants of health in the Northwest Arctic region reveal a community facing layered vulnerabilities:

- Economic stress (poverty, unemployment, energy burden) means households are highly sensitive to cost increases and disruptions.
- Health disparities (especially heart disease and shorter life expectancy) reduce community resilience to additional pollution and environmental stressors.
- Infrastructure gaps (older housing, limited internet, high transport costs) constrain the ability to adopt new systems quickly.
- Demographics (a large youth population) indicate the long-term importance of investing in education, skills, and healthy environments.

Taken together, these conditions suggest that emissions reduction efforts must be framed through equity and resilience. Strategies should minimize additional costs for households, integrate health co-benefits, and account for the structural barriers of remoteness, energy burden, and limited economic opportunity.

## Mitigation Strategies

### Clean & Resilient Energy Transition

Northwest Arctic Borough's largest source of emissions comes from stationary fuel combustion, with homes and community facilities heavily dependent on residual fuel oil for heating and petroleum fuels for electricity generation. This dependency not only drives emissions but also creates one of the highest household energy burdens in the nation. Transitioning away from fuel oil presents both a challenge and an opportunity. Expanding renewable energy sources—such as scaling up wind power, developing solar PV with storage, and exploring district-scale biomass or heat pump systems—could substantially cut emissions while providing long-term cost relief. Targeted retrofits for the region's older housing stock would reduce heating demand and improve indoor environments, while energy resilience hubs powered by clean systems could serve as lifelines during environmental disruptions. These strategies directly link emissions reduction with energy affordability, public health, and community safety.

### Sustainable & Affordable Transportation

Transportation is the borough's second-largest emissions source, with trucks burning gasoline and diesel accounting for the overwhelming share. At the same time, residents face extreme transportation cost burdens, reflecting both geographic remoteness and reliance on fossil-fuel-intensive mobility systems. Addressing this challenge requires a multipronged approach. Transitioning public fleets such as school buses and service vehicles to electric or low-carbon fuels would reduce both emissions and operating costs. For freight and heavy-duty vehicles, renewable diesel or hydrogen could provide viable pathways in the near term. Marine and aviation upgrades are also critical given the importance of boats and small planes for connecting communities. At the community level, investments in shared transportation and modest infrastructure for walking and biking would expand mobility options while reducing per-capita emissions. Together, these actions address emissions while tackling transportation inequities and high household costs.

### Healthy Homes & Community Resilience

The social and health profile of the Northwest Arctic region underscores the importance of linking mitigation strategies to human well-being. High poverty, low insurance coverage, and the nation's highest levels of heart disease prevalence create conditions where environmental stressors could have especially severe impacts. Improving homes and community infrastructure is a direct pathway to both emission reductions and improved health. Retrofitting heating systems to reduce indoor pollution from oil and wood, expanding the construction of energy-efficient Arctic-adapted homes, and reinforcing schools and community facilities as resilience hubs all serve to reduce vulnerability while cutting fossil fuel use. Embedding health equity into these strategies ensures that low-income households receive the greatest support, thereby alleviating both financial strain and disproportionate health risks. These actions would transform mitigation into a community-centered strategy that strengthens safety, health, and long-term resilience.

### Local Economic Development & Workforce Transition

Any emissions reduction strategy in this region must also address economic realities. With unemployment and educational challenges among the highest in the country, mitigation efforts that create jobs and build skills will be far more effective and sustainable. Training programs that prepare residents to install, maintain, and operate renewable energy and efficiency systems would directly align workforce development with community needs. Establishing community-owned energy cooperatives could ensure that financial benefits from clean energy projects remain within the region, supporting local services and reducing poverty. Youth engagement in STEM and vocational pathways related to sustainable energy would prepare the next generation for leadership in the transition. These strategies not only reduce emissions but also empower residents with the tools and opportunities to shape their own energy future, making the energy transition an engine of economic resilience.

### Integrated Food, Land, and Resource Strategies

Although agriculture and waste currently account for little to no emissions in the borough, food and land resources remain central to community health and resilience. Strengthening local food systems through renewable-powered greenhouses, cold storage facilities, and support for subsistence hunting and fishing provides both adaptation and mitigation benefits. Waste-to-energy or composting initiatives could reduce reliance on landfills while supporting food production. Protecting permafrost-rich landscapes and wetlands helps to safeguard cultural resources and traditional hunting grounds while also preserving significant carbon stores. These strategies ensure that mitigation is not only about reducing emissions but also about protecting and enhancing the land-based resources that sustain the community.

### Improved Outcomes for Overburdened and Underserved Communities

Strengthening the role of communities in emissions reduction planning creates a pathway for more equitable and effective outcomes. By embedding local and Indigenous voices into decision-making, strategies can be tailored to reflect cultural practices, subsistence needs, and the lived realities of remote Arctic communities. This ensures that projects—whether in clean energy, transportation, or housing—are not only technically sound but also socially acceptable and widely supported. In turn, this builds trust and encourages community buy-in, both of which are critical for long-term success in regions where past policies have sometimes overlooked local priorities.

Improved outcomes also include expanded capacity for leadership in the clean energy transition. By coupling advisory roles with training, resources, and direct participation in project governance, community representatives can guide investments that generate jobs, reduce household costs, and protect traditional food systems. This approach moves beyond consultation toward shared ownership, ensuring that mitigation strategies simultaneously address emissions, health, and economic resilience while honoring cultural identity. The result is a more durable and just transition—one that is built with the community rather than for it.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Clean & Resilient Energy Transition (renewables, diesel-to-electric swaps, district heat, building efficiency)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                       | Community Benefits                                                                                                                                                |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Targeting stationary fuels can touch ~60% of local emissions. Weatherization and heat-pump/ electric boiler swaps typically cut 20–40% of building fuel use per site; displacing petroleum generation with renewables reduces ~100% of those kWh emissions. | Prioritizing low-income homes, tribal facilities, and public buildings channels benefits to households with highest energy burden and to essential services.      |
| Energy cost savings | High             | Typical space-heat retrofits save 20–30% of heating fuel; single-facility electric boiler conversions can avoid tens of thousands of gallons of oil over system life. Local renewables hedge against volatile delivered-fuel costs.                         | Reduces monthly bills for low-income households and critical community assets (schools/clinics), improving affordability where poverty and unemployment are high. |
| Health benefits     | Moderate–High    | Less combustion in/near homes improves indoor air quality (PM, NOx), supporting cardiovascular outcomes in a community with high heart-disease prevalence.                                                                                                  | Reduced exposure for children/ elders in crowded or older housing; pairs well with home repairs (ventilation, moisture management).                               |
| Resilience          | High             | Microgrids + storage and district heat reduce dependence on fuel deliveries; resilience hubs keep lights/heat on during disruptions.                                                                                                                        | Protects essential services in remote villages; aligns with community-defined emergency priorities.                                                               |
| Disbenefits / risks | Moderate         | Upfront capital; O&M capacity for new tech; intermittent resources require storage/controls; risk of rate impacts if financing isn't equitable.                                                                                                             | Mitigate via no-cost/low-cost participation for at-risk households, local workforce training, a                                                                   |





**Sustainable & Affordable Transportation (public fleets, heavy-duty fuels, marine/aviation efficiency, shared mobility)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                         | Community Benefits                                                                                             |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Surface transport is ~40% of emissions. Near-term: public/school fleet electrification and efficiency in marine/aviation yield meaningful cuts; heavy-duty remains harder (renewable diesel/hydrogen pilots). | School buses, clinic shuttles, freight consolidation benefit communities with limited mobility options.        |
| Energy cost savings | Moderate         | EV fleets can lower fuel/maintenance costs; marine/aviation efficiency reduces fuel burn per trip; savings scale with duty cycle.                                                                             | Lower travel costs improve access to jobs/healthcare; prioritize routes that serve remote at-risk communities. |
| Health benefits     | Moderate         | Reduced roadway diesel/gas exhaust near homes/schools; quieter vehicles; fewer spills.                                                                                                                        | Benefits accrue to neighborhoods closest to roads, staging areas, and ports—often lower-income areas.          |
| Resilience          | Moderate         | Diversifying fuels and improving efficiency reduces exposure to fuel price spikes and supply disruptions.                                                                                                     | Ensures continuity of medical/food/freight access during weather or market shocks.                             |
| Disbenefits / risks | Moderate         | Charging/fueling infrastructure gaps; cold-weather range; higher capex; uncertainty for non-road modes.                                                                                                       | Address with corridor siting in at-risk places, fare protections, and local charging ownership models.         |

**Healthy Homes & Community Resilience (weatherization+, IAQ, Arctic-adapted housing, resilience hubs)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                         | Community Benefits                                                                              |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Deep envelope + heating upgrades typically cut 20–30% of household fuel use; scaled across older stock, reductions are material though incremental.           | Targeting inefficient homes in low-income/tribal communities maximizes per-dollar benefits.     |
| Energy cost savings | High             | Typical households can save hundreds to low thousands of dollars per year on heat/electricity, depending on baseline fuel prices and measures.                | Direct relief for high-burden households; frees income for food, medicine, and schooling.       |
| Health benefits     | High             | IAQ improvements (ventilation, filtration) reduce respiratory and cardiovascular risks; moisture management reduces mold; safer indoor temps in extreme cold. | Disproportionate health gains for households with elders, kids, and those with chronic disease. |
| Resilience          | High             | Tighter, safer homes retain heat longer during outages; community facilities with backup power provide shelter/charging/medicine storage.                     | Improves disaster readiness in remote communities where help is far away.                       |
| Disbenefits / risks | Low–Moderate     | Contractor capacity; construction quality risks; tenant split incentives if landlords don't pass savings; temporary displacement during retrofits.            | Mitigate with local training, tenant protections, and “do-no-harm” rehab standards.             |

**Local Economic Development & Workforce Transition (training, local hiring, community ownership/finance)**

| Outcome             | Potential Impact    | Quantitative / Qualitative Assessment                                                                                            | Community Benefits                                                                         |
|---------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| GHG reduction       | Indirect → Moderate | Not a direct abatement lever, but enables delivery of all other measures at scale and pace (install, operate, maintain).         | Builds capacity for tribal/municipal self-reliance in energy transitions.                  |
| Energy cost savings | Moderate            | Community energy co-ops and on-bill programs can keep savings local; better O&M improves asset life and performance.             | Retains value in community; lowers bills where poverty/unemployment are highest.           |
| Health benefits     | Indirect → Moderate | Quality installs and maintenance sustain IAQ and safety benefits; local jobs improve determinants of health (income, stability). | Prioritize at-risk hiring, apprenticeships, wrap-around supports (childcare, travel).      |
| Resilience          | High                | Local technicians shorten outage duration; community ownership stabilizes services and speeds recovery.                          | Strengthens institutional capacity in rural villages.                                      |
| Disbenefits / risks | Low–Moderate        | Training ramp time; risk of job churn if projects are episodic; admin burden for small entities.                                 | Design multi-year pipelines; bundle projects; provide admin/TA grants to at-risk sponsors. |

**Integrated Food, Land, & Resource Strategies (subsistence support, renewable-powered food systems, composting, land stewardship)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                  | Community Benefits                                                                          |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate     | Composting/diversion and local food infrastructure cut upstream/downstream emissions; land/wetland protection preserves carbon stocks; totals smaller than buildings/transport but meaningful locally. | Supports cultural practices and subsistence economy central to Indigenous well-being.       |
| Energy cost savings | Low–Moderate     | Renewable-powered greenhouses/cold storage reduce diesel genset runtime and food freight costs; savings vary by scale/duty cycle.                                                                      | Lowers food costs and improves access in remote communities.                                |
| Health benefits     | Moderate         | Better food quality/access; reduced open dumps and smoke; cleaner water from improved waste practices.                                                                                                 | Aligns with food security and cultural health priorities in at-risk communities.            |
| Resilience          | High             | Local food and storage buffer supply disruptions; intact lands reduce erosion/flood/permafrost thaw impacts.                                                                                           | Enhances self-determination and safety during extreme events.                               |
| Disbenefits / risks | Low–Moderate     | O&M needs; compost odors/contamination if mismanaged; small GHG returns if programs are under-utilized.                                                                                                | Mitigate with community governance, training, and culturally appropriate siting/operations. |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Equity in design and delivery: Ensures mitigation strategies reduce energy burdens and transportation costs for the most vulnerable households.
- Cultural alignment: Incorporates traditional knowledge and subsistence practices into planning, strengthening community identity and sovereignty.
- Local decision-making power: Positions communities to shape projects, select technologies, and set priorities that reflect lived realities.
- Workforce empowerment: Expands training and job pathways that build skills locally and create opportunities for youth and underemployed residents.
- Trust and participation: Increases community buy-in by demonstrating tangible improvements in affordability, health, and resilience.

Potential disbenefits if not designed equitably:

- Capacity strain: Risk of overburdening local councils or volunteers if project design requires sustained technical or administrative input.
- Equity gaps: Without careful safeguards, programs could benefit higher-income or better-connected households first, leaving out those most in need.
- Financial exposure: Community-owned energy or transport ventures may face financial risk if fuel price shifts, adoption rates, or maintenance costs don't align with projections.
- Technology mismatch: Solutions not adapted to Arctic conditions may underperform, eroding trust in future projects.
- Short-term disruption: Retrofits or infrastructure work could temporarily displace households, interrupt services, or increase utility rates if financing isn't equitable.

### Path Forward

The Northwest Arctic region stands at a critical juncture. With some of the highest energy burdens in the nation, heavy reliance on petroleum fuels, and significant health and socioeconomic disparities, the stakes for sustainability action are high. Yet these same conditions create a powerful opportunity: strategies that reduce emissions can also alleviate poverty, improve public health, and strengthen community resilience. By focusing on the most impactful areas—transitioning away from fuel oil in heating, expanding renewable electricity generation, and improving transportation efficiency—the region can make meaningful progress toward both sustainability and community goals.

The path forward requires sustained investment, strong partnerships, and deep community leadership. The role of leadership will be essential in ensuring that strategies are implemented equitably and that benefits flow first to those households most burdened by high costs and health risks. Aligning state and federal resources with local priorities will accelerate adoption of clean energy systems, housing improvements, and workforce development programs. Over time, these efforts will build not only a lower-emission energy system, but also a more self-reliant and healthy community.

By taking these steps, the Northwest Arctic can serve as a model for rural and Indigenous-led emissions reduction action in Alaska—demonstrating how local leadership, cultural grounding, and equity-centered planning can drive meaningful emissions reductions while improving lives today and safeguarding future generations.





Petersburg Borough faces a unique set of opportunities and challenges in pursuing emissions reduction. With total criteria pollutants and greenhouse gas emissions driven nearly equally by stationary fuel use in buildings by gasoline- and diesel-powered transportation, the community's emissions are vastly reduced through its hydropower usage. At the same time, nearly one-third of residents are seniors, more than one-fifth live with disabilities, and many households experience high energy burdens, limited internet access, or language barriers. These social determinants of health underscore the importance of designing sustainability strategies that not only reduce emissions but also improve affordability, health, and resilience for the most vulnerable residents.

This roadmap recognizes that the transition to a low-carbon future must be equitable. Emissions reduction actions in Petersburg can deliver wide-reaching benefits—healthier homes, more reliable and affordable energy, safer transportation, and stronger community resilience—while also reducing emissions in line with Alaska's Sustainable Energy Action Plan. By prioritizing strategies that address both emissions and equity, the Borough can ensure that at-risk populations experience tangible improvements in quality of life alongside sustainability progress.

### Overall Assessment

Most impactful, high-benefit strategies for GHG reduction and Community co-benefits:

1. Building Electrification & Deep Weatherization
2. Maintain high reliability of hydro supply and ensure adequate backup capacity
3. Cleaner, Accessible Transportation (Fleet + Truck Transition)

Together, these three strategies address around 70–80% of community emissions while also directly targeting benefits: reducing household costs, improving housing and health, and ensuring resilient, equitable access to energy and mobility.



## Emissions Data Overview

Total Modeled Emissions: 28,048 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (45.02%)

- Residential Sector (31.86%)
  - o Electricity: 60.48 mt CO<sub>2</sub>e (0.24% of total)
  - o Propane: 53.58 mt CO<sub>2</sub>e (0.22% of total)
  - o Residual Fuel Oil No. 5: 7,779.42 mt CO<sub>2</sub>e (31.32% of total)
  - o Wood & Wood Residuals: 20.31 mt CO<sub>2</sub>e (0.08% of total)
- Commercial Sector (13.16%)
  - o Distillate Fuel Oil No. 1: 3,024.18 mt CO<sub>2</sub>e (12.18% of total)
  - o Propane: 230.86 mt CO<sub>2</sub>e (0.93% of total)
  - o Wood & Wood Residuals: 8.39 mt CO<sub>2</sub>e (0.03% of total)
  - o Electricity: 5.76 mt CO<sub>2</sub>e (0.02% of total)
- Industrial Sector: 0%

### Transportation (54.98%)

By fuel type:

- Diesel fuel: 2,808.05 mt CO<sub>2</sub>e (11.31%)
- Motor gasoline: 10,846.68 mt CO<sub>2</sub>e (43.67%)
- Electricity (for electric vehicles, etc.): 0.00 mt CO<sub>2</sub>e (negligible)

By vehicle type (within transport):

- Trucks: 12,471.83 mt CO<sub>2</sub>e (91.34% of transport emissions)
- Passenger vehicles: 1,164.19 mt CO<sub>2</sub>e (8.53%)
- Motorcycles: 18.71 mt CO<sub>2</sub>e (0.14%)

### Electricity Generation (0.27%)

- Electricity consumption: 55,218 MWh
- Generation sources:
  - o Hydro: 54,642 MWh → 0.00 mt CO<sub>2</sub>e (0%)
  - o Petroleum: 576 MWh → 161 mt CO<sub>2</sub>e (100%)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- Stationary combustion (heating, facility operations) and transportation are almost equal shares of emissions (~50 % each), indicating that decarbonization in both building energy and mobility is critical.
- Within stationary emissions, Residual Fuel Oil No. 5 is by far the dominant fuel — this suggests that much of the heating/facility energy in Petersburg currently relies on heavy fuel oil.
- Electricity generation is almost entirely hydro, contributing zero emissions in this context. Diesel generation is minimal.
- In the transportation sector, gasoline use (especially through trucks) is the major source of emissions, dwarfing diesel or electric use.



## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Exposure:** Anticipated changes in extreme weather are relatively high (59.09 percentile), suggesting the region will face noticeable weather variability and weather-related risks.
- **Disaster Losses:** Annualized disaster losses are modest (\$100,208), ranking low nationally (7.95 percentile), but this may understate risks due to geographic isolation and high dependence on marine/air access.
- **Air Quality & Toxics:** Diesel particulate matter (0.01) and toxic releases are negligible, indicating low current industrial air pollution. However, cancer risk from air toxics (9.0) is present.
- **Hazardous Sites:** Few hazardous facilities are nearby, though Risk Management Plan facility proximity ranks high (73.3 percentile), meaning certain industrial vulnerabilities exist.
- **Housing Stock Risks:** Nearly half of housing is pre-1980s (50.83%), and a significant portion is pre-1960s (27%), raising concerns about asbestos, lead, and weatherization gaps.
- **Flood Risk:** About 8% of properties face flood risk, ranking at the 57th percentile, which could be exacerbated by environmental changes.

Implications: Petersburg faces moderate environmental risks, especially from aging housing and environment-related flooding. While current pollution exposures are low, resilience planning will be important as older infrastructure and weather shifts interact.

### Public Health Indicators

- **Chronic Disease:** Asthma (3.4%), diabetes (3.37%), and high blood pressure (11.75%) rates are below national averages, with heart disease ranking near the midpoint nationally (47th percentile).
- **Mental Health:** Poor mental health prevalence (4.52%) is lower than national averages (29.55 percentile), but access to services in a remote setting may still be limited.
- **Cancer:** Prevalence (2.29%) is moderate, aligning with national patterns.
- **Life Expectancy:** The average life expectancy is notably high (84.6 years), ranking very favorably (low percentile for low life expectancy at 4.0).

Implications: Overall health indicators are positive, with strong longevity. However, limited healthcare infrastructure in remote areas may mask vulnerabilities, especially if environmental stressors (e.g., flooding or pollution) rise.

### Socioeconomic Factors

- **Poverty & Income:** About 18.7% of the population lives below 200% of the poverty line, near national averages. However, income inequality (GINI index 0.42, 68.75 percentile) suggests disparities in wealth distribution.
- **Education:** High school non-completion is elevated (10.8%), ranking at the 82.7 percentile nationally, signaling an educational attainment gap.
- **Employment:** Unemployment is low (2.6%), though this likely reflects seasonal and fisheries-based economies.
- **Housing & Costs:** Renter occupancy is moderate (29.4%), while housing cost burden is 21.9% of households—relatively manageable. Median home values (\$227,400) are mid-range.
- **Insurance & Digital Access:** Uninsured rate (12.7%) and lack of internet access (20%) both rank high, limiting resilience. Digital exclusion is especially pronounced (75th percentile).
- **Demographics:** A significant senior population (27%) and high disability rates (21.1%, 94.3 percentile) create added health and service needs. Limited English proficiency is also high (92.6 percentile), creating communication challenges.
- **Housing Type:** Mobile homes (8%) and older housing (pre-1960s at 27%) indicate vulnerability to energy inefficiency and storm damage.

Implications: Petersburg's socioeconomic profile reveals vulnerabilities around education, digital access, disability, and aging populations. These inequities may amplify environmental risks and reduce adaptive capacity.

### Transportation Insecurity

- Access: Transportation access score is extremely poor (1.11, at 98.8 percentile nationally), reflecting the region's geographic isolation and dependence on limited ferry and air systems.
- Costs: Household transportation cost burden is modest (0.14, 57.8 percentile), but this likely reflects constrained mobility rather than affordability.
- Safety: Traffic fatality rates are high (5.58 deaths per 100,000; 84.7 percentile), suggesting safety concerns despite limited road networks.

Implications: Petersburg's geographic isolation and very limited transportation options are major barriers to equity and resilience. Any environment-related disruptions (storms, fuel cost increases, ferry service interruptions) will compound existing vulnerabilities.

### Intersection with Emissions Reduction Planning

Petersburg Borough's social determinants of health highlight both resilience and fragility. The region enjoys strong longevity and relatively good baseline health, but faces challenges in aging housing, digital exclusion, transportation isolation, and high disability rates. Emissions reduction strategies will need to account for:

- The fragility of older housing stock, which will require investment in weatherization and resilience to flooding.
- The transportation bottleneck, which heightens dependence on fossil fuels for marine and air access while making clean mobility transitions complex.
- Social inequities, particularly among seniors, people with disabilities, and households lacking digital access, who may be disproportionately impacted by both environmental risks and the costs of adaptation.
- The importance of community-level resilience, as healthcare access, communications, and emergency management are limited by remoteness and infrastructure gaps.

In short, while Petersburg is relatively healthy, its structural and geographic vulnerabilities make equitable, community-driven approaches essential in considering future emissions reduction.

## Mitigation Strategies

### Clean & Resilient Energy Transition

Petersburg's stationary combustion emissions are dominated by Residual Fuel Oil No. 5, used for heating. This reliance on heavy oils reflects both aging housing stock and limited local alternatives. Use of hydro is a community strength.

- Building Electrification & Weatherization: Support fuel-switching from oil to electric heat pumps, paired with major investment in weatherization for older homes (particularly pre-1960s and pre-1980s housing). This reduces both emissions and household energy burdens, which are already high (73rd national percentile).
- Balance stability with renewables integration and explore with the region's wholesale electric provider Southeast Alaska Power Agency (SEAPA) the opportunities for community-scale solar or biomass.
- Storage: Build out battery storage for critical facilities to ensure resilience during outages, especially critical given Petersburg's isolation and high proportion of seniors and disabled residents.

Why it matters: This strategy tackles the single largest emissions source while directly improving housing conditions, reducing household energy cost burdens, and increasing resilience for vulnerable populations.

### Low-Carbon Transportation & Access

Transportation accounts for nearly half of emissions, with trucks and gasoline being the largest contributors. Given Petersburg's high transportation insecurity (98.8th percentile) and dependence on marine/air systems, solutions must balance emissions with mobility needs.

- **Fleet Transition:** Begin phased electrification of municipal fleets, school buses, and light-duty public service vehicles. Target gasoline-powered trucks through incentives for hybrid/electric replacements.
- **Marine & Aviation Innovation:** Support pilot projects for electric ferries or hybrid vessels, and explore sustainable aviation fuel partnerships, given the borough's reliance on ferries and air transport.
- **Constraint:** Electrification opportunities should be pursued as shipping limitations allow, prioritizing municipal fleets where procurement is more feasible. Feasibility will be key factor, considering limitations on barge transfers of EVs. Emphasis instead can be on hybrid vehicles, efficiency improvements in heavy equipment, and active mobility.
- **Active & Shared Mobility:** Strengthen safe walking and biking infrastructure to reduce short-trip gasoline demand, while supporting community car-share models for residents with limited access.

Why it matters: Reducing transportation emissions also improves safety and lowers household dependence on imported fuels. This will particularly benefit low-income and digitally disconnected households with limited mobility options.

### Healthy, Affordable, and Resilient Housing

Housing is a cross-cutting vulnerability in Petersburg, with 27% of homes built pre-1960s, high disability rates, and digital exclusion. Housing improvements can yield energy efficiency, affordability, and health co-benefits.

- **Targeted Weatherization & Energy Retrofits:** Prioritize retrofitting older homes, mobile homes, and renter-occupied units with insulation, air sealing, and efficient appliances.
- **Indoor Air Quality & Health:** Address air toxics exposure by reducing reliance on fuel oil heating, while integrating asthma- and cancer-prevention design measures in building programs.
- **Resilient Housing Programs:** Support elevation or flood-proofing of homes in the 8% flood-risk zone, with emphasis on senior and disabled households who face heightened vulnerabilities.

Why it matters: Housing retrofits directly address both emissions and the borough's health inequities, while reducing the risk of displacement from future environmental impacts.

### Local Food, Waste, and Resource Systems

While modeled emissions from waste and agriculture are currently negligible, local circular systems can enhance resilience and reduce dependency on imports.

- **Composting & Waste Diversion:** Establish small-scale composting and recycling initiatives to reduce landfill reliance and methane leakage.
- **Local Food & Energy Nexus:** Promote greenhouse or aquaponic systems powered by renewable energy, reducing reliance on imported food while strengthening community food security.
- **Wood Residuals Utilization:** Explore sustainable use of wood waste as supplemental bioenergy, provided safeguards are in place to protect air quality.

Why it matters: Diversifying local food and waste systems supports emissions reductions indirectly while building resilience against supply chain disruptions, which are frequent in remote Alaskan communities.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes for at-risk populations in Petersburg will come from aligning emissions reduction with health equity and affordability goals. Energy retrofits and housing weatherization programs reduce exposure to cold, damp, and inefficient housing—conditions that disproportionately affect seniors and people with disabilities. Transitioning from heavy fuel oil to cleaner heating sources not only lowers



emissions but also improves indoor air quality, benefiting residents with chronic health conditions such as asthma or heart disease. Cost-burdened households will see relief through lower utility bills and targeted subsidies, reducing financial strain while ensuring access to resilient, safe housing.

At the same time, building out local renewable energy and electrified transportation improves community independence from imported fuels, lowering vulnerability to price spikes and disruptions—factors that most acutely affect low-income and digitally excluded households. By designing outreach and rebate programs in accessible languages and formats, Petersburg can ensure that limited English proficiency residents are fully included in the transition. Taken together, these strategies create a healthier, more resilient community where vulnerable groups are not left behind but instead experience tangible improvements in affordability, mobility, and overall well-being.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

#### Clean & Resilient Energy Transition (hydropower utilization, local renewables + storage, strategic electrification of loads)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                               | Community Benefits                                                                                                                      |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Displaces heavy fuel oil and diesel in heating and transportation.                                                                                                                  | Cuts emissions near homes/ services used by seniors & disabled; enables low-emission heating where air quality co-benefits matter most. |
| Energy cost savings | Moderate–High    | Hydro + storage lowers volatility vs. delivered fuels; 5–20% retail cost stabilization possible; greater savings if paired with building load reductions.                           | Stabilizes bills for cost-burdened households; reduces exposure to fuel spikes that disproportionately harm fixed-income seniors.       |
| Health benefits     | Moderate         | Less local combustion → lower indoor/outdoor pollutants; indoor gains depend on building upgrades; community-wide asthma/heart stressors reduced.                                   | Most helpful for elders, disabled people with chronic conditions; lower caregiver burden.                                               |
| Resilience          | High             | Energy storage maintains loads for critical facilities during outages; fewer fuel deliveries needed; hours→days of ride-through achievable for key sites.                           | Keeps clinics, shelters, dialysis, communications online; vital for residents with mobility/health limitations.                         |
| Disbenefits / risks | Low–Moderate     | Upfront capital; tariff impacts if not sequenced; substation/line constraints; siting and cultural concerns if new assets needed.                                                   | If financed regressively, could raise bills; ensure affordability protections and targeted credits to at-risk households.               |
| Constraint          | Low–Moderate     | Based on SEAPA participation, only allowed 150kW of customer net-metered solar; additional solar poses stability risks. Customer battery systems limited to behind-the-meter backup | Coordinate with SEAPA to evaluate any future renewable additions.                                                                       |

**Low-Carbon Transportation & Access (municipal/light-duty fleet electrification, charging, safer walking/biking, marine/aviation pilots, shared mobility)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                  | Community Benefits                                                                                                            |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Transportation ~50% of community emissions; phased electrification + mode shift could cut 15–30% of transport CO <sub>2</sub> e over 10–15 yrs (heavier share if marine pilots scale). | Prioritize routes that serve at-risk neighborhoods; reduce exposure to tailpipe pollution on main corridors.                  |
| Energy cost savings | Moderate         | EVs typically \$0.08–\$0.15/mi equivalent vs. higher gasoline costs; municipal fleet TCO ↓; marine hybridization reduces fuel intensity.                                               | Lower household transport costs with shared EVs, community chargers; ensure equitable charger placement and off-peak pricing. |
| Health benefits     | Moderate         | Less PM/NO <sub>x</sub> along streets and near docks; safer streets investments reduce injuries; active mobility supports chronic disease prevention.                                  | Safer, accessible routes benefit elders and disabled residents; cleaner air benefits respiratory-sensitive groups.            |
| Resilience          | Moderate         | Diversifies away from imported fuels; vehicle-to-load for emergency sites; ferry/aviation pilots reduce disruption sensitivity.                                                        | Reliable access to clinics/food during fuel disruptions; chargers at community hubs help residents without home parking.      |
| Disbenefits / risks | Moderate         | Upfront EV costs; charger reliability in extreme weather; limited grid capacity; marine/aviation tech uncertainty.                                                                     | Risk of inequitable charger siting or pricing; mitigate with equity siting maps, subsidized rates, and ADA-compliant design.  |



**Healthy, Affordable, and Resilient Housing (weatherization, heat pumps, envelope/IAQ upgrades, flood hardening for at-risk homes)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                     | Community Benefits                                                                                                         |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Building fuel use is a major stationary source; combined 20–35% reduction for upgraded homes; heat pumps eliminate most oil use since hydro is available. | Targets older/mobile homes, renters, and seniors first to maximize equity and cumulative savings.                          |
| Energy cost savings | High             | Deep retrofits + electrification commonly 20–40% bill savings; single-family annual savings often \$1k–\$2k+ where oil is displaced.                      | Big relief for fixed-income seniors and disabled residents; reduces arrears and shutoff risk.                              |
| Health benefits     | High             | Warmer/drier homes reduce mold and respiratory triggers; improved ventilation cuts pollutants; safer heating systems.                                     | Strong benefits for residents with asthma/COPD, infants, and elders; improves in-home caregiving conditions.               |
| Resilience          | Moderate–High    | Better envelopes maintain safe temps during outages (+12–24 hours survivability); flood-proofing lowers displacement risk.                                | Critical for mobility-limited residents who can't evacuate easily; reduces emergency shelter demand.                       |
| Disbenefits / risks | Low–Moderate     | Contractor capacity limits; split-incentives for rentals; upfront match requirements; poor install risks performance.                                     | Avoid exclusion via no-cost options, on-bill tariffing, landlord participation, quality-assurance checks in at-risk homes. |





**Local Food, Waste, and Resource Systems (community composting, recycling, local food production with clean energy, careful use of wood residuals)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                              | Community Benefits                                                                                                        |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate     | Waste/ag currently small share locally; composting/diversion can avoid hundreds–low thousands mtCO <sub>2</sub> e over time; food localization reduces freight emissions modestly. | Lower disposal costs and cleaner sites benefit all; job pathways in organics mgmt suitable for local hires.               |
| Energy cost savings | Low–Moderate     | Modest savings via reduced hauling/inputs; greenhouse projects offset some imported food costs; potential revenue from compost sales.                                              | Reduces food insecurity exposure among low-income households; community gardens aid elders/disabled.                      |
| Health benefits     | Moderate         | Better waste handling → fewer vectors/odors; fresh produce access improves diet quality.                                                                                           | Strong co-benefits for elders and disabled residents with limited mobility to stores; culturally relevant foods possible. |
| Resilience          | Moderate         | Local organics handling and food production buffer supply disruptions; compost improves soils for community gardens.                                                               | In disruptions, at-risk households gain stable local food access; community programs double as social support hubs.       |
| Disbenefits / risks | Low              | Siting/nuisance issues if poorly managed; small per-capita GHG impact compared to energy/transport.                                                                                | Ensure equitable siting, odor control, and inclusive participation to avoid burdening at-risk areas.                      |





### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy burden: Reduces utility bills for low-income and fixed-income households.
- Improved health outcomes: Better air quality and safer housing directly help seniors and people with chronic illness or disabilities.
- Resilience during disruptions: Critical facility storage, weatherized homes, and accessible transport improve safety for those less able to evacuate or adapt.
- Accessible information and participation: Multilingual outreach and digital inclusion allow limited English proficiency and digitally disconnected households to benefit.
- Job and training opportunities: Green workforce programs create pathways for residents without diplomas or facing employment barriers.

Potential disbenefits if not designed equitably:

- Upfront cost barriers: Even with rebates, low-income households may face financing or landlord challenges.
- Equity in access: If chargers, incentives, or programs are not equitably sited, at-risk populations risk being excluded.
- Administrative complexity: Complicated application or enrollment processes may leave out households with language or digital barriers.
- Risk of regressive cost recovery: Utility tariff changes or program surcharges could raise bills without strong protections.
- Capacity strain: Limited local workforce and contractor shortages could delay benefits to the most vulnerable households.

### Path Forward

Petersburg Borough has both urgent needs and unique strengths as it moves toward a low-carbon future. The emissions profile makes clear that the greatest opportunities for reduction lie in transitioning away from heavy fuel oil in buildings and in shifting transportation systems toward cleaner, more efficient alternatives. These strategies are not only the most impactful for emissions reduction, but also the most aligned with improving health, affordability, and resilience for the community's most vulnerable residents.

The path forward will require a phased, community-centered approach. In the near term, Petersburg can focus on “no-regret” strategies such as deep weatherization, targeted electrification of homes, and initial municipal fleet transitions, while securing resources to coordinate with SEAPA to evaluate any future renewable additions and resilience measures. Over the medium term, investments in cleaner marine or aviation technologies will help reduce dependence on imported petroleum fuels. Throughout, the Borough should embed equity considerations into every stage: ensuring at-risk populations have priority access to incentives, affordable financing, outreach in accessible languages and formats, and direct community participation in decision-making.

By aligning emissions reductions with improvements in housing, energy security, and mobility, Petersburg Borough can chart an emissions reduction pathway that strengthens community health and resilience. This integrated approach will ensure that progress on Alaska's Comprehensive Sustainable Energy Action Plan is not only measured in tons of carbon reduced, but also in the lived experience of safer, healthier, and more affordable lives for all Petersburg residents.

# Hyder, Prince of Wales-Hyder Census Area

Population: 65  
Census Tract: 2198000300

Hyder, in the Prince of Wales–Hyder Census Area of Alaska, is a uniquely small and isolated community whose emissions profile and social determinants of health highlight both vulnerabilities and opportunities. With a population comprised entirely of older adults, the community faces a disproportionately high energy burden, a heavy prevalence of chronic disease, and reliance on aging housing stock. At the same time, Hyder’s emissions are highly concentrated: nearly all criteria pollutants and greenhouse gas emissions come from transportation, particularly freight and truck fuel use, while stationary combustion and electricity generation play minor roles. This concentrated emissions profile, paired with high local costs of energy and health risks from fuel dependence, underscores the importance of aligning emissions reduction strategies with the lived realities of at-risk communities. The strategies prioritized for Hyder must deliver not only carbon reductions but also measurable improvements in affordability, health, and resilience.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Weatherization and Fuel Oil Reduction in Homes and Businesses Community-scale renewable generation with storage
2. Beneficial Electrification (Heat Pumps & Public Building Conversions)
3. Weatherization & Housing Energy Efficiency

Together, these strategies directly address Hyder’s emissions profile, which is dominated by transportation and heating). They generate immediate and visible household benefits (lower bills, healthier homes, safer energy supply). They also tackle equity gaps by targeting high-burden at-risk households, ensuring that sustainability actions produce social as well as environmental gains.

## Emissions Data Overview

Total Modeled Emissions: ~1,337 mt CO<sub>2</sub>e.

### Stationary Combustion (1.29%)

- Residential (0.32 % of total)
  - 4.28 mt CO<sub>2</sub>e from wood/wood residuals (~0.32 % of total)
- Commercial Sector (0.97% of total)
  - 12.06 mt CO<sub>2</sub>e from distillate Fuel Oil No.1 (~0.9 %)
  - 0.92 mt CO<sub>2</sub>e from propane (~0.07 %)
  - 0.03 mt CO<sub>2</sub>e from wood residuals (negligible)
- Industrial Sector: 0%. Solid waste and wastewater emissions were not included in this dataset.

### Transportation (53.76%)

- By fuel type:
  - Motor gasoline: 1,051.58 mt CO<sub>2</sub>e (~78.64 %)
  - Diesel fuel: 268.40 mt CO<sub>2</sub>e (~20.07 %)
  - Electricity: 0.02 mt CO<sub>2</sub>e (negligible)
- By vehicle type:
  - Trucks: 1,214.30 mt CO<sub>2</sub>e (~91.99 % of transportation emissions)
  - Passenger vehicles: 103.97 mt CO<sub>2</sub>e (~7.88 %)
  - Motorcycles: 1.73 mt CO<sub>2</sub>e (~0.13 %)

### Electricity Generation

Total electricity usage: ~0.13 MWh

Generation mix:

- Wind: 0.03 MWh (0.00 mt CO<sub>2</sub>e)
- Hydro: 0.05 MWh (0.00 mt CO<sub>2</sub>e)
- Diesel: 0.05 MWh (~0.02 mt CO<sub>2</sub>e)

Overall, electricity emissions are negligible relative to total community emissions.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use):

- Not included in this dataset

### Key Takeaways

- Transportation is the primary emissions source in Hyder, accounting for nearly all (98.7 %) of the community's carbon footprint.
- Heavy trucks dominate the vehicle emissions profile, indicating that freight or service vehicles (rather than light passenger commuting) are likely the main drivers.
- Stationary combustion (heating, commercial fueling) and electricity generation are minimal contributors to CO<sub>2</sub>e emissions in this community context.
- Zero emissions from industrial, waste, and land-use sectors reflect the limited presence of industrial or agricultural activity in Hyder, or that such emissions are below modeled thresholds.



## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Risk:** Anticipated changes in extreme weather events are relatively high (40.34), highlighting exposure to environmental variability.
- **Disaster Loss:** Annualized disaster losses are extremely low in dollar terms (\$452.96), suggesting limited prior damage but potentially reflecting small population and infrastructure base.
- **Air Quality & Pollution:** Diesel PM exposure, toxic releases, and hazardous waste proximities are all at 0.00, indicating low current industrial pollution exposure.
- **Superfund Sites:** Minimal proximity risk (2nd percentile nationally).
- **Housing Vulnerability:** High prevalence of pre-1980s housing (75th percentile), which may have structural, insulation, and energy efficiency challenges.

Implications: While Hyder faces limited current industrial pollution, the aging housing stock and exposure to extreme weather highlight vulnerabilities. Future resilience strategies must account for older housing that may be less energy efficient and more susceptible to environmental impacts.

### Public Health Indicators

- **Chronic Disease Burden:** Hyder reports high rates of cancer (100th percentile nationally), high blood pressure (97th percentile), and diabetes (92nd percentile).
- **Asthma:** Above-average asthma prevalence (67th percentile), possibly linked to environmental or housing quality factors.
- **Mental Health:** Poor mental health prevalence (66th percentile) suggests psychosocial challenges within the small community.
- **Life Expectancy:** Reported as 0.00, which likely indicates data suppression due to the small population size, not absence of life expectancy data.

Implications: The heavy burden of chronic disease, especially cancer and cardiovascular risk factors, signals significant public health vulnerabilities. These conditions could limit adaptive capacity and increase sensitivity to environment-related stressors.

### Socioeconomic Factors

- **Poverty & Employment:** Data suggests 0.00% under 200% of the poverty line, unemployment, and housing cost burden. This is likely a data artifact due to the very small population rather than true absence of economic hardship.
- **Age Profile:** 100% of the population is age 65 or older, putting the community at the 92nd percentile nationally for elderly population. There are no residents under 17.
- **Housing Characteristics:** A very high share of mobile homes (98th percentile nationally) indicates housing fragility in extreme weather and high energy costs.
- **Energy Burden:** At 97th percentile, households face very high energy costs relative to income, straining economic resilience.
- **Income Inequality:** GINI Index places the community at the 99th percentile, suggesting stark inequality, though this too may be skewed by the small population size.

Implications: Hyder's demographics are dominated by older residents, many in mobile homes and experiencing very high energy burdens. This creates both health and economic vulnerability, while income inequality could limit equitable adaptation measures.



### Intersection with Emissions Reduction Planning

The social determinants of health in Hyder show a highly vulnerable, aging, and economically strained community with limited adaptive capacity. Key considerations for emissions reduction planning include:

- **Energy Burden:** High household energy costs mean efficiency and clean energy transitions could directly benefit residents but may require substantial support.
- **Health Burden:** Chronic illness prevalence could amplify the health benefits of pollution reduction but also strains capacity to engage in adaptation programs.
- **Housing:** Mobile homes and older housing stock will shape the feasibility of energy retrofits and resilience upgrades.
- **Demographics:** An elderly-only population limits workforce availability for implementation and increases sensitivity to environmental stressors.
- **Isolation:** Transportation and geographic remoteness make Hyder particularly dependent on external systems (e.g., fuel shipments), underscoring the importance of local resilience.

### Mitigation Strategies

#### Residential Strategies

- **Weatherization & Energy Efficiency**
  - High energy costs, reliance on heating fuel, and older housing stock create financial and health burdens.
  - State programs like the Alaska Housing Finance Corporation (AHFC) Weatherization Assistance have historically reduced energy costs by 29% per household while improving indoor air quality and durability.
  - **Implication:** For Hyder's small and isolated population, even modest weatherization upgrades can substantially reduce household expenses, improve comfort, and cut emissions.
- **Beneficial Electrification (Heat Pumps)**
  - Southeast Alaska's legacy hydropower makes electrification viable. Transitioning from heating oil to air-source heat pumps could eliminate residential carbon emissions in hydro-served communities
  - **Implication:** Hyder's access to affordable hydropower positions it well for electrification, though upfront cost and contractor availability are barriers.

#### Non-Residential (Public Facilities & Schools)

- **Energy Efficiency Retrofits**
  - Schools and public facilities are high energy users in small communities. Weatherization and electrification of public buildings reduces government operating costs and improves resilience.
  - **Implication:** For Hyder, upgrading public buildings (school, community facilities) ensures essential services are less vulnerable to fuel supply disruptions and provides community-wide benefits.

#### Solid Waste

- **Composting Programs**
  - Southeast Alaska tribes and municipalities are already advancing composting to reduce methane emissions and landfill burdens
  - **Implication:** Hyder's small waste stream could integrate with regional composting efforts, reducing costs of waste transport and cutting methane emissions.

#### Transportation

- **Marine & Aviation Reliance**
  - Hyder is road-isolated from the rest of Alaska, with limited local road use but reliance on marine and cross-border transport.

- Electrification of personal vehicles is less impactful here than elsewhere, but shore power for marine vessels and improved efficiency of regional shipping routes matter.
- Implication: Sustainability strategies should focus less on EV charging and more on marine electrification or regional coordination with Canadian partners.

### Electric Generation

- Local Microgrid Resilience
  - Southeast's hydropower resources reduce reliance on diesel generation in many communities. Where diesel persists, hybridization with renewables (solar + storage) can reduce costs and emissions.
  - Implication: Hyder's reliance on cross-border energy relationships (with Stewart, BC) means ensuring a stable, low-carbon supply is key. Diesel backup reduction is a likely opportunity.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes for at-risk communities emerge when mitigation strategies are explicitly tied to both emissions reduction and local well-being. By prioritizing measures that address energy burdens, housing resilience, and health disparities, communities like Hyder can experience tangible benefits that go beyond carbon accounting. For example, weatherization and electrification upgrades not only cut household emissions but also reduce energy poverty, improve indoor air quality, and make homes safer for elderly residents who are disproportionately vulnerable to cold and extreme weather events.

Another key outcome is economic stability. High energy costs often consume a disproportionate share of household income in vulnerable or remote communities. Programs that lower fuel consumption through efficiency or transition to hydro-powered electrification help redirect household resources toward food, healthcare, and community needs. This shift alleviates financial stress, decreases income inequality, and supports long-term community viability. Even modest gains in energy efficiency or renewable deployment can substantially change the affordability landscape in small rural towns.

Finally, improved outcomes for at-risk communities extend to resilience and self-determination. Reducing reliance on imported fuels enhances local security, particularly in isolated regions where supply chains are fragile. By integrating local knowledge with modern energy solutions, communities are empowered to shape their own sustainable future. The co-benefits—lower emissions, healthier living conditions, and stronger local economies—illustrate how emissions reduction can simultaneously advance equity and public health outcomes.



Hyder: By Isderion, wikimedia

**Benefit (Disbenefit) Quantification or Qualitative Analysis****Weatherization & Housing Efficiency**

| Outcome             | Potential Impact                       | Quantitative / Qualitative Assessment                      | Community Benefits                                 |
|---------------------|----------------------------------------|------------------------------------------------------------|----------------------------------------------------|
| GHG Reduction       | Moderate - 29% household reduction     | 29% household energy savings; moderate emissions reduction | High - elderly benefit from lower burden           |
| Energy Cost Savings | High - hundreds-thousands \$/yr        | 29% lower energy bills                                     | High - reduces energy poverty                      |
| Health Benefits     | High - better indoor air quality       | Asthma, CVD relief; safer homes                            | High - elderly vulnerable                          |
| Resilience          | Moderate - improved housing durability | Homes more resilient to cold/extreme weather               | High - elderly security                            |
| Disbenefits / Risks | Moderate - high upfront costs          | Skilled labor shortages; high per-home investment          | Moderate - cost barriers for vulnerable households |

**Beneficial Electrification**

| Outcome             | Potential Impact                           | Quantitative / Qualitative Assessment                           | Community Benefits                         |
|---------------------|--------------------------------------------|-----------------------------------------------------------------|--------------------------------------------|
| GHG Reduction       | High - up to 100% sector reduction         | Eliminates heating oil emissions                                | High - clean heating for vulnerable        |
| Energy Cost Savings | High - \$500-\$1,500/yr savings            | Switch from oil to hydro/renewables reduces volatility          | High - equitable relief                    |
| Health Benefits     | High - indoor/outdoor air cleaner          | Cuts PM2.5 from heating oil/wood                                | High - critical for elderly health         |
| Resilience          | Moderate - reduces supply chain dependence | More reliable energy for heat, care                             | High - supports fixed-income seniors       |
| Disbenefits / Risks | High - very high upfront costs             | Heat pump installs cost \$10k-\$20k; electrical upgrades needed | High - risk of exclusion without subsidies |



**Transportation Improvements**

| Outcome             | Potential Impact                     | Quantitative / Qualitative Assessment                    | Community Benefits                           |
|---------------------|--------------------------------------|----------------------------------------------------------|----------------------------------------------|
| GHG Reduction       | Very High - ~99% of emissions sector | 132 mt CO <sub>2</sub> e saved with 10% reduction        | High - critical emissions sector             |
| Energy Cost Savings | High - freight fuel costs lowered    | Less diesel/gas imports, cost stability                  | High - lowers cost of goods                  |
| Health Benefits     | High - less local diesel pollution   | Improves respiratory/ cardiovascular outcomes            | High - elderly gain most                     |
| Resilience          | High - reduces fuel dependence       | Supply resilience improved cross-border                  | High - improves security                     |
| Disbenefits / Risks | High - infrastructure/cost challenge | Cross-border coordination required; per-capita cost high | High - may bypass residents if cost too high |

**Solid Waste (Composting)**

| Outcome             | Potential Impact                     | Quantitative / Qualitative Assessment                 | Community Benefits                         |
|---------------------|--------------------------------------|-------------------------------------------------------|--------------------------------------------|
| GHG Reduction       | Low - small emissions share          | Tens of mt CO <sub>2</sub> e avoided                  | Moderate - symbolic reduction              |
| Energy Cost Savings | Moderate - \$10k-\$30k/yr savings    | Lower landfill transport costs                        | Moderate - community-level benefit         |
| Health Benefits     | Low - small direct health gain       | Engagement > health benefit                           | Low - symbolic equity gain                 |
| Resilience          | Low - modest resilience benefit      | Keeps some waste local, less dependent on transport   | Moderate - supports sustainability framing |
| Disbenefits / Risks | Low - requires consistent engagement | Community participation required; low impact vs. cost | Low - minimal but symbolic equity risk     |

**Electricity & Microgrid Resilience**

| Outcome             | Potential Impact                          | Quantitative / Qualitative Assessment               | Community Benefits                                  |
|---------------------|-------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|
| GHG Reduction       | Low - negligible now, prevents rebound    | Avoids diesel rebound as electrification grows      | Moderate - long-term emissions guardrail            |
| Energy Cost Savings | Moderate - avoids high diesel costs later | Capital cost high, protects long-term affordability | Moderate - equity over time                         |
| Health Benefits     | Moderate - indirect health benefit        | Reliable energy avoids stress during outages        | Moderate - supports elderly                         |
| Resilience          | High - enhances energy security           | Microgrids improve reliability for isolated towns   | High - resilience                                   |
| Disbenefits / Risks | Moderate - high per-capita costs          | Capital-intensive for small population              | Moderate - risks exclusion if funding not equitable |



### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- **Reduced Energy Burden**
  - Weatherization and electrification lower household fuel costs, a critical benefit in communities with very high energy burdens.
  - Frees up household income for food, healthcare, and other essentials.
- **Improved Health Outcomes**
  - Reduced indoor pollutants (oil/wood burning) and outdoor diesel/gas emissions lessen risks of asthma, cancer, and cardiovascular disease.
  - Elderly residents benefit from safer, warmer homes and reduced vulnerability to extreme cold.
- **Resilience & Security**
  - Less dependence on imported fuels strengthens community self-reliance and reduces vulnerability to supply chain disruptions.
  - Microgrid and renewable systems maintain critical services during outages.

Potential disbenefits if not designed equitably:

- **High Upfront Costs**
  - Weatherization, electrification, and microgrids require capital investment beyond household or small-community means.
  - Without targeted subsidies, projects may exclude those most in need.
- **Workforce & Capacity Barriers**
  - Limited access to trained contractors in remote areas slows implementation and increases costs.
  - Reliance on outside labor may reduce local economic benefits.
- **Scale & Efficiency Trade-Offs**
  - Very small population means per-capita investment costs are high, creating risks of being overlooked in regional or state-level planning.
- **Risk of Exclusion**
  - If funding prioritizes larger, more accessible communities, some communities may be left behind despite high vulnerability.
  - Programs that require significant upfront household contributions (e.g., heat pump installs) may disproportionately exclude low-income residents.
- **Implementation Fatigue**
  - Repeated program demands (paperwork, participation, maintenance) may overwhelm small, aging communities.

### Path Forward

For Hyder, the most impactful strategies are clear: transportation improvements, beneficial electrification of heating and public buildings, and weatherization of the housing stock. These measures directly address the largest sources of emissions while delivering high-value co-benefits to an aging, energy-burdened population. They improve health outcomes by reducing indoor and outdoor air pollution, strengthen resilience by lowering dependence on imported fuels, and relieve financial stress through lower household energy costs.

Moving forward, the path for Hyder should focus on three priorities:

1. **Targeted Investment** – Ensure adequate state and federal resources reach small, isolated communities despite high per-capita costs. Subsidies, contractor support, and cross-border coordination will be essential.
2. **Equity Integration** – Build program designs that explicitly include at-risk households, protecting against exclusion from high upfront costs or limited workforce capacity.
3. **Sequencing & Scalability** – Start with weatherization and electrification in homes and public facilities, then build toward transportation and regional freight solutions, ensuring early wins that build trust and capacity.

By prioritizing strategies that jointly reduce emissions and address social determinants of health, Hyder can serve as a model for how sustainability action in Alaska's small and vulnerable communities can advance equity, resilience, and sustainability together.

# Metlakatla, Prince of Wales-Hyder Census Area



Metlakatla, located on Annette Island in Southeast Alaska, is a unique community with both strengths and challenges as it considers pathways to reduce air pollution emissions. Unlike many regions, Metlakatla already benefits from a nearly 100 percent hydropower-based electricity supply, meaning its grid emissions are effectively zero. This clean electricity foundation provides a strong platform for future strategies, but also shifts the focus toward other sources of carbon pollution—primarily the heavy reliance on petroleum fuels for heating and transportation.

The community's emissions inventory shows that stationary combustion in residential and commercial buildings and transportation account for nearly all emissions, with fuel oil, distillate, and gasoline as the dominant fuels. These sources overlap with pressing local challenges: an aging and inefficient housing stock, high transportation costs, and elevated rates of chronic health conditions. Addressing these sectors is not only central to achieving meaningful emission reductions, but also essential to improving affordability, resilience, and health outcomes across the community.

This analysis identifies the most impactful mitigation strategies for Metlakatla and considers how these actions can support better outcomes for residents, especially those who face the greatest burdens. By focusing on strategies that align carbon reductions with local benefits, Metlakatla can chart a roadmap that both contributes to the State's Comprehensive Sustainable Energy Action plan and strengthens the community's long-term well-being.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Transition Away from Fuel Oil in Homes
2. Efficiency and Clean-Heat Retrofits in Public and Community Buildings
3. Clean Transportation Transition

The three most impactful emissions reduction strategies are (1) residential fuel oil transition, (2) community/public building retrofits, and (3) transportation electrification. Together, these target over 80% of total emissions, while also delivering high-value co-benefits such as reduced energy costs, healthier living conditions, and greater resilience.

## Emissions Data Overview

Note that these data are for the entire Census Area, which contains three Census Tracts.

Total Modeled Emissions: 4,778 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (59.63%)

- Residential Sector (29.35%)
  - Propane: 29.77 mt CO<sub>2</sub>e (0.62% of total)
  - Residual Fuel Oil No. 5: 1,338.95 mt CO<sub>2</sub>e (28.02% of total)
  - Wood & Wood Residuals: 33.50 mt CO<sub>2</sub>e (0.07% of total)
- Commercial Sector (30.29%)
  - Distillate Fuel Oil No. 1: 1,340.88 mt CO<sub>2</sub>e (28.06% of total)
  - Propane: 102.36 mt CO<sub>2</sub>e (2.14% of total)
  - Wood & Wood Residuals: 3.72 mt CO<sub>2</sub>e (0.02% of total)
- Industrial Sector: 0%

### Transportation (40.37%)

By fuel type:

- Diesel fuel: 392.16 mt CO<sub>2</sub>e (8.21%)
- Motor gasoline: 1,536.44 mt CO<sub>2</sub>e (32.16 %)

By vehicle type (within transport):

- Trucks: 1,774.18 mt CO<sub>2</sub>e (91.99 % of transport emissions)
- Passenger vehicles: 151.89 mt CO<sub>2</sub>e (7.88%)
- Motorcycles: 2.53 mt CO<sub>2</sub>e (0.13%)

### Electricity Generation

- Electricity consumption: 18,223.19 MWh
- Generation sources:
  - Hydro: 18,223.19 MWh → 0.00 mt CO<sub>2</sub>e (no direct emissions)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- Stationary combustion is the largest emissions source, accounting for nearly 60 % of Metlakatla's emissions. This underscores that heating, building energy use, and commercial fuel consumption are critical leverage points.
- Within stationary uses, residual fuel oil No. 5 and distillate fuel oil No. 1 are the dominant fuels. These are relatively high-carbon, heavy petroleum-based fuels, suggesting opportunities for fuel switching, efficiency, or alternative heating.
- Transportation emissions are substantial (about 40 %), with gasoline use (in trucks and passenger vehicles) being the largest share, though diesel also contributes meaningfully.
- The very high share of emissions from trucks suggests that goods movement, freight, and commercial vehicle operations are a notable part of the burden.
- Metlakatla's electricity supply is almost fully hydropower-based, meaning no community emissions from electricity generation. This is a major strength and positions the community ahead of many others in the transition to clean energy.

## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Vulnerability:** Anticipated changes in extreme weather are relatively high (19.32), suggesting increased risks from storms and extreme weather-related events.
- **Disaster Loss Exposure:** While annualized disaster loss (\$11,108.55) is low nationally (2.84 percentile), vulnerability may still increase due to geographic isolation.
- **Air Quality & Toxics:** Diesel particulate matter exposure is minimal (0.01), and toxic releases are very low (1.00 percentile). However, cancer risk from air toxics is moderate (8.00 percentile).
- **Hazardous Facilities:** No RMP facilities or hazardous sites nearby, though one formerly used defense site is present.
- **Housing Risks:** Pre-1980s housing (53.15 units; 76.14 percentile nationally) raises concerns about aging infrastructure and exposure to legacy hazards.
- **Transportation Corridors:** No major highways nearby; moderate airport proximity (39.77 percentile) reduces some risks but contributes to noise and emissions.

Implications: Metlakatla's environmental health risks are not dominated by industrial or urban pollution but by aging housing stock, exposure to severe weather, and legacy defense sites. These conditions may create hidden health burdens and amplify existing risks within the community.

### Public Health Indicators

- **Chronic Conditions:** Diabetes (6.85; 74.43 percentile) and high blood pressure (18.50; 63.07 percentile) are notable concerns. Heart disease prevalence is high nationally (83 percentile).
- **Asthma & Cancer:** Asthma (5.90; 63.07 percentile) and cancer prevalence (2.80; 53.98 percentile) are moderate.
- **Mental Health:** Poor mental health prevalence (8.15; 63.07 percentile) signals stress and social pressures.
- **Life Expectancy:** Average life expectancy (76.7) is below national averages; low life expectancy falls in the 67th percentile nationally.

Implications: Chronic disease burden is significant in Metlakatla, especially heart disease and diabetes. These conditions may worsen under environmental stressors, reinforcing the importance of preventative health strategies and supportive infrastructure in emissions reduction planning.

### Socioeconomic Factors

- **Poverty & Income Inequality:** Nearly 40% live under 200% of the federal poverty line (89.20 percentile nationally), with moderate inequality (GINI 0.38).
- **Employment & Education:** High unemployment (8.40; 88.64 percentile) and limited educational attainment (8.60 without HS diploma; 71.88 percentile).
- **Housing Conditions:** Renters comprise 23.18% (31.82 percentile), but 19% of homes are pre-1960s and 12.20% are mobile homes (92.05 percentile), raising housing vulnerability.
- **Healthcare Access:** Uninsured rate is high (18.10; 78.41 percentile), and disability prevalence is very high (24.90; 98.30 percentile).
- **Digital Divide:** Lack of internet access (28.20; 86.65 percentile) creates barriers for education, telehealth, and economic development.
- **Demographics:** A relatively young population (27.6% under 17) but also a significant elder population (12.83% over 65; 74.43 percentile).

Implications: Metlakatla faces interconnected socioeconomic disadvantages, including poverty, unemployment, disability prevalence, and digital exclusion. These structural inequities may limit adaptive capacity and must be addressed for equitable sustainability solutions.



### Transportation Insecurity

- Access & Costs: Transportation access is poor (0.87; 94.64 percentile nationally), while household transportation cost burden is high (0.17; 80.92 percentile).
- Safety: No traffic fatalities recorded, but reliance on limited and costly transportation networks constrains mobility.

Implications: Geographic isolation, limited transit options, and high costs create transportation vulnerability, reducing access to healthcare, jobs, and services. This dependency increases sensitivity to fuel and energy policy shifts.

### Intersection with Emissions Reduction Planning

Metlakatla's social determinants of health reveal systemic vulnerabilities that intersect strongly with emissions reduction planning:

- Health Burden: Chronic diseases and disabilities may be worsened by poor air quality or heat events, requiring health-centered adaptation approaches.
- Housing & Infrastructure: Aging housing and mobile homes are less energy efficient, making energy efficiency upgrades critical to both public health and emission reduction.
- Poverty & Energy Burden: High poverty and elevated energy/transportation costs mean households have limited financial flexibility to adopt clean energy or efficiency measures without subsidies or support.
- Digital Divide & Education: Limited internet access and education gaps may hinder engagement in planning, technology adoption, and workforce development in clean energy.
- Cultural & Demographic Factors: A youthful population, alongside elders with high needs, means solutions must be intergenerationally equitable and culturally appropriate.

Overall, Metlakatla's conditions suggest that emissions reduction efforts must be designed with a strong emphasis on equity, affordability, and health co-benefits, ensuring that strategies do not worsen existing vulnerabilities but instead deliver resilience and well-being to the community.

## Mitigation Strategies

### Transition Away from Fuel Oil in Buildings

The largest share of emissions in Metlakatla comes from stationary combustion in both residential and commercial buildings. Homes built before 1980 and a high proportion of mobile homes are particularly vulnerable to inefficiency, leaving residents with high energy costs and exposure to pollutants from fuel oil heating. Replacing these systems with electric heat pumps and improving insulation and building envelopes can drastically reduce emissions. To capture these benefits without creating new problems, transitions to electric heat should be carefully planned and phased in alongside efficiency upgrades to avoid unnecessary stress on the electrical grid and to minimize reliance on backup diesel generation during peak demand or cold snaps. This strategy would not only cut fuel dependence but also lower household bills and improve indoor comfort. For commercial and community buildings—such as schools, health centers, and administrative offices—similar retrofits, planned in coordination with utility capacity and reliability needs, would reduce emissions while ensuring public facilities are safer and more dependable during cold weather and emergencies.

### Improving Energy Use in Community Facilities

Commercial stationary combustion contributes a significant portion of emissions, underscoring the importance of targeting shared infrastructure. Schools, clinics, and government buildings play central roles in community life, especially in a geographically isolated place like Metlakatla. By retrofitting these facilities with efficient systems and renewable integration where possible, the community can lower its collective carbon footprint, reduce operational costs, and create public spaces that remain resilient under environmental stress.

### Transforming the Transportation System

Transportation is the second largest source of emissions, driven by gasoline use in passenger vehicles and the dominance of heavy trucks. This also aligns with residents' high transportation cost burdens and limited mobility options. Electrifying vehicles and expanding charging infrastructure would create a pathway to lower emissions while making transportation more affordable over time. Support for electric passenger vehicles, alongside electrification of local fleets such as delivery and service trucks, can be coupled with improvements in transportation access to reduce the community's dependence on costly imported fuels.

### Addressing Marine and Freight Emissions

As an island community, Metlakatla depends on ferries and boats for transport and commerce, and also relies on aircraft to fly in freight, mail, and essential materials. While these emissions are not fully detailed in the inventory, they are likely significant contributors to both community costs and local air pollution. Partnerships with ferry systems, fishing operators, and air carriers to explore hybrid or electric vessels, or to transition toward low-sulfur and alternative fuels, could deliver meaningful reductions. Reducing marine and aviation emissions would not only improve air quality near ports, docks, and the airport, but also enhance the reliability and affordability of vital transport links.

### Building Energy Security with Local Renewables

Even though electricity is currently hydropower-based, backup diesel generation remains a vulnerability, particularly during outages. Developing distributed renewable systems—such as solar arrays paired with storage or small-scale wind—could reinforce energy security. These systems would ensure that critical services such as healthcare and education remain powered in emergencies and would reduce the need to fall back on diesel.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes for at-risk populations in Metlakatla will emerge most clearly where sustainability strategies directly intersect with daily life. Replacing fuel oil with clean heating systems, for example, lowers household energy costs and reduces exposure to harmful indoor air pollutants. For families living in older or mobile homes—where efficiency is poor and bills are disproportionately high—these changes can mean the difference between living in unsafe, drafty conditions and enjoying stable, healthy housing. Similarly, transportation electrification and marine efficiency improvements not only cut emissions but also reduce reliance on costly imported fuels, helping households that already face the highest transportation burdens.

Beyond energy and cost savings, these interventions strengthen access to reliable services, healthier public spaces, and improved community resilience. Retrofitted schools, clinics, and community buildings provide safe havens during extreme weather, while digital inclusion and workforce training ensure that residents most at risk of being left behind instead gain opportunities to participate in and benefit from the transition. For at-risk populations, this means that sustainability action does not merely reduce emissions on paper—it delivers tangible improvements in health, economic stability, and quality of life.

**Benefit (Disbenefit) Quantification or Qualitative Analysis****Transition away from fuel oil in homes (heat pumps + weatherization)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                    | Community Benefits                                                                                                          |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Residential stationary $\approx 1,402$ mt CO <sub>2</sub> e. If 40–60% of oil heat is replaced over time, potential reduction $\approx 560$ –840 mt CO <sub>2</sub> e. Weatherization compounds savings. | Cuts the largest household-combustion source; directs benefits to older/mobile homes that face high bills and poor comfort. |
| Energy cost savings | High             | Heat pumps + envelope upgrades typically reduce heating energy costs 30–60% vs. fuel oil (hydro power is low-cost). Household annual savings meaningful even at small scales.                            | Reduces energy burden for low-income renters/owners; lowers arrears risk; stabilizes winter budgets.                        |
| Health benefits     | High             | Reduced indoor combustion byproducts, lower moisture/mold risks from envelope fixes; better thermal comfort.                                                                                             | Disproportionate benefits for homes with overcrowding, asthma/CVD risks, elders, and children.                              |
| Resilience          | Moderate–High    | Tight shells retain heat longer in outages; heat pumps provide efficient cooling during heat waves.                                                                                                      | Improves safety-in-place for vulnerable residents during extreme weather.                                                   |
| Disbenefits / risks | Low–Moderate     | Upfront costs; contractor capacity; landlord-tenant split incentives; panel upgrades may be needed.                                                                                                      | Mitigated by no-cost/low-cost programs, on-bill tariffing, and targeted installs for highest-need households first.         |

**Efficiency & clean-heat retrofits in public/community buildings**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                  | Community Benefits                                                                                 |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Commercial/community stationary $\approx 1,447$ mt CO <sub>2</sub> e. If 30–50% reduction through heat pumps + envelope + controls, potential $\approx 435$ –725 mt CO <sub>2</sub> e. | Community-wide benefit from fewer petroleum deliveries and lower baseline emissions.               |
| Energy cost savings | High             | Large, predictable savings from heating fuel avoidance and O&M reductions; frees operating dollars.                                                                                    | Savings can be reinvested into services used by low-income residents (schools, clinics, admin).    |
| Health benefits     | High             | Better IAQ/thermal comfort in schools, clinics, halls; reduced exposure to fuel storage/handling near people.                                                                          | Improves the quality of spaces most used by elders, children, and those with chronic conditions.   |
| Resilience          | High             | Critical facilities stay habitable longer; options for limited backup storage at key hubs.                                                                                             | Safer shelters and continuity of services for vulnerable households during outages/extremes.       |
| Disbenefits / risks | Low–Moderate     | Capital intensity; construction disruption; sequencing across multiple buildings.                                                                                                      | Manage via phased retrofits, performance contracts, and scheduling to preserve access to services. |

**Clean transportation transition (fleet and personal vehicles; charging)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                       | Community Benefits                                                                                      |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Transportation $\approx$ 1,929 mt CO <sub>2</sub> e (gasoline $\sim$ 1,536 mt, diesel $\sim$ 392 mt). Near-term 10–25% turnover could cut $\approx$ 190–480 mt CO <sub>2</sub> e; medium-term 30–50% yields 580–965 mt as charging expands. | Prioritizing service/delivery fleets amplifies community benefit; reduces exposure along common routes. |
| Energy cost savings | Moderate–High    | EVs: lower “fuel” and maintenance costs vs. gasoline/diesel; benefits grow with mileage.                                                                                                                                                    | With fair charging access and financing, lowers total cost of mobility for lower-income drivers.        |
| Health benefits     | Moderate         | Reduces tailpipe pollutants along residential roads and near schools.                                                                                                                                                                       | Tangible benefits for respiratory/ cardiovascular risks in dense or frequently traveled areas.          |
| Resilience          | Moderate         | Local charging plus backup power can sustain essential mobility; less dependence on fuel deliveries.                                                                                                                                        | Critical trips (health, groceries) more reliable during supply disruptions if chargers remain powered.  |
| Disbenefits / risks | Moderate         | Upfront vehicle costs; charger reliability; cold-weather range; equity of charger siting.                                                                                                                                                   | Address via community charging hubs, used-EV support, smart siting at multifamily/central locations.    |

**Marine and freight efficiency (hybrid/electric pilots, low-sulfur/alt fuels, operational improvements)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                               | Community Benefits                                                                               |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Marine not itemized; if marine is $\sim$ 10–20% of transport ( $\sim$ 190–385 mt CO <sub>2</sub> e), efficiency/hybridization of 10–30% yields $\approx$ 20–115 mt CO <sub>2</sub> e. Early pilots build learning for larger gains. | Cleaner air near docks and waterfront neighborhoods; benefits for workers and nearby households. |
| Energy cost savings | Moderate         | Fuel efficiency cuts diesel spend; hybridization reduces idle/low-load waste.                                                                                                                                                       | Potential to lower costs of goods and travel, indirectly helping price-sensitive households.     |
| Health benefits     | Moderate         | Less diesel exhaust and noise near ports; improved worker exposures.                                                                                                                                                                | Benefits accrue to fishers, dock workers, and adjacent at-risk residents.                        |
| Resilience          | Moderate         | Operational efficiency and diversified fuels can buffer against diesel price spikes/supply shocks.                                                                                                                                  | More reliable connections for essential goods and medical travel.                                |
| Disbenefits / risks | Low–Moderate     | Technology maturity, capex for retrofits, limited vendor options, training needs.                                                                                                                                                   | Mitigate via grants, phased pilots, and focusing first on high-hours vessels/ferry segments.     |



**Local renewables + storage for backup and critical loads (microgrids/solar + batteries)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                         | Community Benefits                                                                                   |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low              | Grid electricity is hydro (zero-carbon). Primary GHG impact is displacing backup diesel (likely a small share, e.g., <1–3% of total ⇒ <50–140 mt CO <sub>2</sub> e avoided when outages would have occurred). | Secondary emissions reduction value; main value is reliability and protecting health during outages. |
| Energy cost savings | Moderate         | Limited direct savings given hydro; batteries can reduce generator runtime and peak diesel use at facilities.                                                                                                 | Lowers operating costs at clinics/schools/community hubs that serve at-risk residents.               |
| Health benefits     | Moderate         | Keeps refrigeration, medical devices, communications, and air filtration running during outages; reduces diesel exhaust from gensets.                                                                         | Protects medically vulnerable residents; preserves medicine/food safety.                             |
| Resilience          | High             | Islandable microgrids for clinics, shelters, and water systems provide material continuity of service.                                                                                                        | Directly safeguards those most at risk from power loss (elders, infants, device-dependent).          |
| Disbenefits / risks | Low–Moderate     | Capital costs; battery lifespan/replacement; O&M capacity.                                                                                                                                                    | Address via right-sizing, grants, warranties, and local O&M training.                                |

**Cross-Cutting Community Benefits and Disbenefits**

Across all strategies, benefits for community benefits include:

- Lower household energy burden: Replacing fuel oil with efficient electric systems may reduce heating costs, which disproportionately helps low-income families.
- Improved indoor environments: Retrofits reduce exposure to combustion pollutants, mold, and dampness, leading to better health outcomes for those with asthma, cardiovascular disease, or other chronic conditions.
- Access to healthier public spaces: Upgrades in schools, clinics, and community facilities create safer, more comfortable environments during extreme weather.
- Transportation affordability and reliability: Electrification lowers fuel costs and reduces dependency on imported fuels, improving mobility for vulnerable residents.
- Resilience during disruptions: Local renewables and backup storage safeguard vulnerable households and critical services during outages, protecting those least able to recover from shocks.
- Community economic opportunity: Workforce training and digital access improvements tied to mitigation measures can create jobs and new skills locally.

Potential disbenefits if not designed equitably:

- High upfront costs: Without subsidies or financing, households with limited resources could be excluded from early adoption.
- Capacity constraints: Limited local contractor and technical expertise could delay upgrades and raise costs.
- Equity of access: EV charging, public building upgrades, or marine retrofits may initially benefit better-resourced households or institutions unless targeted toward those with the highest needs.

- Technology risks: Cold-climate performance of some clean technologies, reliability of charging networks, and durability of storage systems could create gaps in service.
- Implementation disruption: Retrofits in homes or public buildings may temporarily displace services or create short-term inconvenience for residents with fewer alternatives.

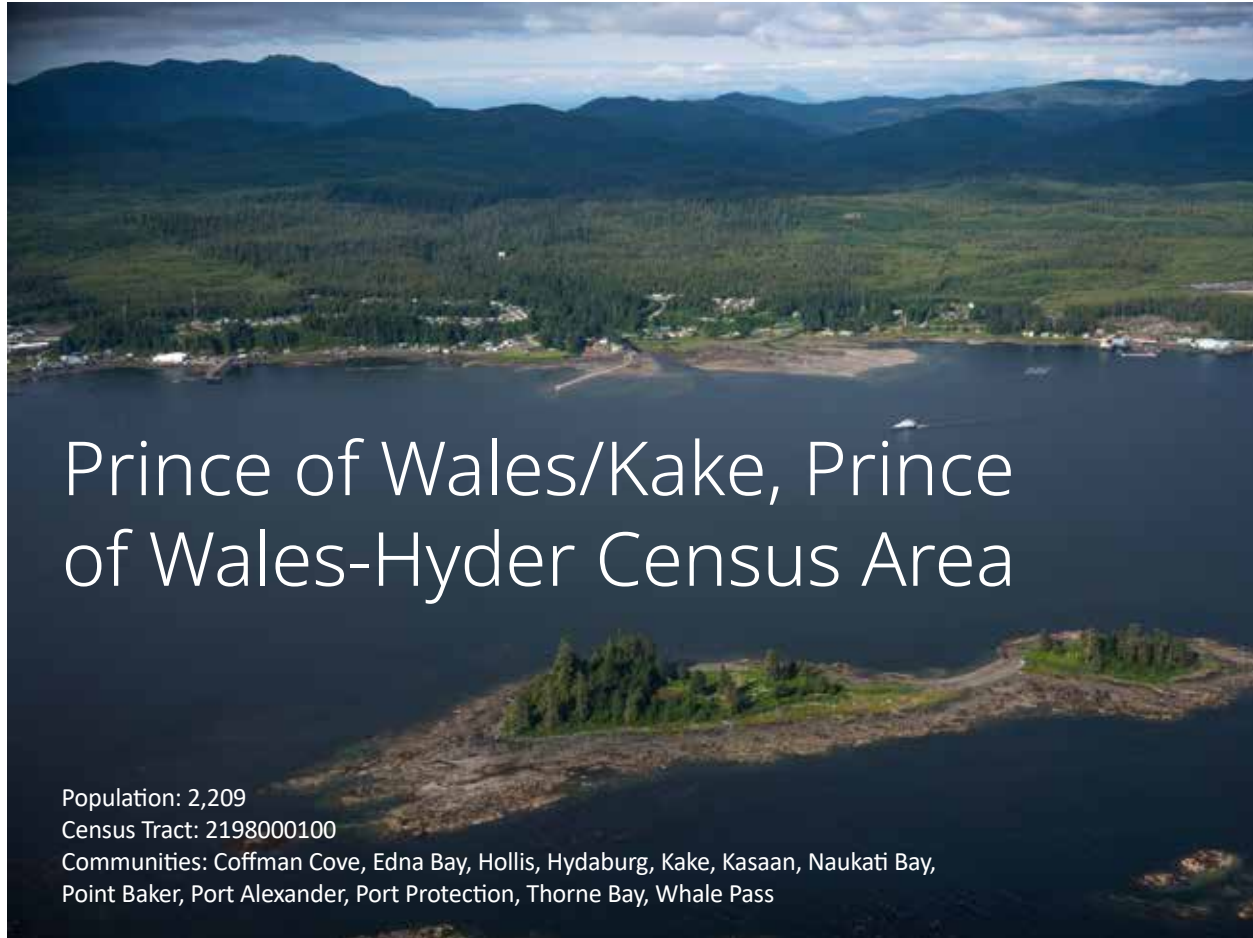
### Path Forward

Metlakatla's emissions profile is defined by its reliance on fuel oils for heating and gasoline and diesel for transportation, even as it benefits from a clean, primarily hydropower-based electricity supply. This unique starting point means the community's most effective mitigation strategies are not in decarbonizing electricity, but rather in transitioning homes and public facilities away from fuel oil, modernizing transportation systems, and strengthening resilience through targeted renewable and storage solutions. These strategies require careful coordination to avoid added stress to the existing electrical grid. Together, these efforts can address over 80 percent of local emissions while also reducing household costs, improving public health, and enhancing the reliability of essential services.

Moving forward, a practical path for Metlakatla begins with near-term investments in building efficiency and heating system conversions, since these deliver both immediate carbon savings and substantial benefits to residents living in older, inefficient housing. In parallel, planning should accelerate around transportation electrification, with a focus on fleet and charging infrastructure that leverages the community's clean electricity base. Over the medium term, scaling up marine efficiency pilots, expanding distributed renewable energy for resilience, and aligning health and energy programs will help build a more secure and sustainable community. Throughout, an emphasis on outcomes for households facing the greatest burdens will ensure that the benefits of emissions reduction action are felt equitably, protecting the most vulnerable while strengthening community-wide capacity.

By aligning emissions reduction strategies with improved health, affordability, and resilience, Metlakatla can position itself as a model for rural and island communities across Alaska. The transition will require sustained investment, local workforce development, and strong partnerships, but it offers the promise of a cleaner, healthier, and more resilient future.





The Prince of Wales/Kake region, in the Prince of Wales–Hyder Census Area, faces a unique combination of challenges: high dependence on fuel oil and gasoline, significant transportation emissions dominated by trucks, and persistent reliance on petroleum-fired electricity despite available hydro resources. At the same time, the community is shaped by social determinants that place many residents with elevated poverty, high disability rates, limited internet access, and substantial energy burdens. Any mitigation strategy must therefore be evaluated not only for its emissions impact but also for its ability to deliver tangible improvements in affordability, health, and resilience for these households. The following analysis outlines the cross-cutting benefits and potential disbenefits of mitigation strategies, with a focus on how they intersect with beneficial outcomes.

### Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Weatherization and Fuel Oil Reduction in Homes and Businesses Community-scale renewable generation with storage
2. Truck-Centric Transportation Improvements and Electrification
3. Renewable Energy Expansion and Microgrid Upgrades

Together, these strategies target the largest emissions sources—transportation, fuel oil heating, and petroleum-fired electricity—while simultaneously addressing the biggest vulnerabilities for at-risk communities: high energy burdens, poor housing quality, chronic health conditions, and dependence on costly imported fuels. They offer immediate, tangible improvements in cost of living and health outcomes, while laying the foundation for deeper decarbonization.

## Emissions Data Overview

Note that the Price of Wales-Hyder Census area contains three census tracts. The modeled emissions data are for the entire area.

Total Modeled Emissions: 61,723 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (46.24%)

- Residential (27.15% of total)
  - Electricity: 4,731.52 mt CO<sub>2</sub>e (7.67%)
  - Natural Gas: 277.31 mt CO<sub>2</sub>e (0.45%)
  - Propane: 750.16 mt CO<sub>2</sub>e (1.22%)
  - Residual Fuel Oil No. 5: 10,691.36 mt CO<sub>2</sub>e (17.32%)
  - Wood & Wood Residuals: 305.42 mt CO<sub>2</sub>e (0.49%)
- Commercial Sector (17.85%)
  - Electricity: 6,550.47 mt CO<sub>2</sub>e (10.61%)
  - Distillate Fuel Oil No. 1: 4,852.23 mt CO<sub>2</sub>e (7.86%)
  - Propane: 370.42 mt CO<sub>2</sub>e (0.60%)
  - Wood & Wood Residuals: 13.47 mt CO<sub>2</sub>e (0.02%)
- Industrial Sector: 0%. Solid waste and wastewater emissions were not included in this dataset.

### Transportation (53.76%)

- Motor Gasoline (main contributor • 26,433.32 mt CO<sub>2</sub>e (42.83%)
- Diesel Fuel: 6,746.78 mt CO<sub>2</sub>e (10.93%)
- Electricity (vehicles): 0.73 mt CO<sub>2</sub>e (negligible)

In terms of vehicle types:

- Trucks: 30,523.68 mt CO<sub>2</sub>e (91.99%)
- Passenger vehicles: 2,613.62 mt CO<sub>2</sub>e (7.88%)
- Motorcycles: 43.54 mt CO<sub>2</sub>e (0.13%)

### Electricity Generation

- Total electricity consumption: 51,547.53 MWh
  - Petroleum-fueled generation: 39,176.12 MWh → 11,282.72 mt CO<sub>2</sub>e (100%)
  - Hydro 12,371.41 MWh → 0.00 mt CO<sub>2</sub>e (0.00%)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use):

- Not included in this dataset

### Key Takeaways

- Transportation dominates emissions (53.8%), especially trucks powered by gasoline.
- Stationary combustion is significant (46.2%), with residential fuel oil (No. 5) at 17.3% and commercial electricity at 10.6%.
- Electric generation contributes 15.5% of emissions—despite substantial hydro use, all emissions come from petroleum-fired generation.
- Sectors like industrial, waste, and agriculture did not contribute CO<sub>2</sub>e emissions in the 2022 inventory.





## Social Determinants of Health

### Environmental Conditions

- Low industrial hazards: Diesel particulate matter exposure is negligible, and toxic releases to air are at the 1st percentile nationally. No hazardous waste sites, RMP facilities, or defense sites are nearby. This means residents are not regularly exposed to industrial pollutants.
- Moderate legacy risks: Proximity to Superfund sites is at the 51st percentile, and about one-third of housing was built before 1980. This suggests possible exposure to older contaminants and less-efficient housing stock.
- Low current physical risks: No proximity to high-volume roads reduce baseline exposure to roadway pollution.
- Transportation and infrastructure exposure: About 5.8% of the tract is close to an airport, which may contribute modest air and noise pollution.
- Environmental vulnerability: Anticipated changes in extreme weather are high (68.75), indicating significant future environmental stress even though current disaster losses are low.

Implications: The region currently experiences relatively little industrial pollution exposure, but its vulnerability to future extreme weather-related events is high. Legacy contamination and aging housing stock may compound risks over time, especially for households with limited resources to adapt.

### Public Health Indicators

- Chronic disease prevalence: Diabetes is highly prevalent (84th percentile), with elevated rates of heart disease and high blood pressure. These conditions increase vulnerability to environmental stress.
- Other health conditions: Asthma, cancer, and poor mental health all occur at above-average rates, making the population more sensitive to environment-related health stressors.
- Life expectancy: At 77.9 years, average life expectancy is slightly lower than national norms, reflecting cumulative health burdens.

Implications: High levels of chronic disease mean residents are less resilient to disruptions in healthcare access, food security, or environmental conditions. Environment-related changes that worsen air quality, increase stress, or limit healthcare access will have disproportionate effects on this population.

### Socioeconomic Factors

- Poverty and inequality: Nearly 40% of residents live below 200% of the federal poverty line, and income inequality is above average. This indicates significant economic strain.
- Education and employment: Nine percent of adults lack a high school diploma (higher than national averages). Unemployment is moderate at 3.6%, but lower educational attainment limits opportunity.
- Housing conditions: About 25% of units are renter-occupied, and 11.5% are mobile homes (91st percentile nationally), increasing vulnerability to weather damage. Home values are modest compared to national levels.
- Healthcare and connectivity access: About 24% of residents are uninsured (93rd percentile), and 36% lack internet access (94th percentile). These barriers limit healthcare access, communication, and participation in resilience planning.
- Household burdens: Energy burden is high at 5% of income (90th percentile), signaling costly energy use for residents. Housing cost burden is relatively low, but utility costs are the main financial strain.
- Demographics: Nearly 22% of residents are 65 or older (84th percentile), and disability prevalence is very high at 24% (97th percentile). These groups are especially vulnerable to disruptions.

Implications: Economic hardship, high disability rates, and poor access to healthcare and internet limit the adaptive capacity of this community. These constraints make residents more sensitive to cost increases and less able to participate in or benefit from programs without targeted equity measures.

### Intersection with Emissions Reduction Planning

- **Low current exposure, high future risk:** While industrial pollution exposure is minimal, the community is expected to face significant environmental challenges, such as extreme weather and energy cost pressures. This makes long-term resilience planning more urgent.
- **Health fragility:** High prevalence of chronic illnesses means even small increases in environmental stressors—such as heat waves, air quality decline, or service disruptions—could lead to outsized health consequences.
- **Economic strain:** Elevated poverty levels, high disability prevalence, and limited access to healthcare and internet mean residents have fewer resources to adapt. Without targeted support, sustainability strategies could inadvertently deepen inequities.
- **Energy burden as leverage point:** The very high energy burden signals a key opportunity. Emissions reduction strategies that reduce household energy costs (through efficiency, renewables, or subsidies) would deliver immediate and visible benefits.
- **Equity and inclusion needs:** Older adults, disabled residents, and low-income households represent a large share of the community and must be central to planning. Strategies designed without them risk leaving behind the majority of residents.
- **Framing of benefits:** Because direct industrial pollution is low, messaging and engagement should emphasize resilience, affordability, and health protection rather than solely emissions reduction. This framing will align sustainability goals with immediate community needs.

For the Prince of Wales/Kake Census Tract, emissions reduction efforts will be most effective if they are equity-driven, health-conscious, and economically beneficial. By linking pollution reduction to lower household costs, stronger health outcomes, and greater community resilience, strategies can gain local support while addressing the region's structural vulnerabilities.

### Mitigation Strategies

#### Transportation: Tackling the Largest Source of Emissions

Transportation is the dominant emissions driver in the region, responsible for more than half of total CO<sub>2</sub>e. Trucks account for over 90% of transportation emissions, with gasoline as the primary fuel.

- **Optimize before electrify:** The first and most cost-effective step is reducing unnecessary fuel consumption. Driver training, idle-reduction initiatives, and better freight coordination can deliver measurable fuel savings right away. These operational changes are relatively easy to implement and directly benefit at-risk households through reduced costs for goods and services.
- **Transition fleets and hubs:** Over time, electrification of light- and medium-duty trucks should be prioritized where charging is most reliable—public fleets, school buses, service vehicles, and depot-based freight. Installing Level-2 chargers at schools, clinics, ferry terminals, and harbors provides both workforce and resident access. These investments support equitable mobility while cutting the community's largest emissions source.

#### Energy Transition in Buildings

Stationary combustion—mostly from residential fuel oil and commercial electricity/fuel oil use—is the second-largest source of emissions. For residents, this sector is also the most visible driver of high energy burdens.

- **Weatherization as a first step:** Expanded home weatherization reduces heating oil use, lowers bills, and improves indoor health conditions. This is especially critical for older adults and residents with chronic health conditions. Weatherization also provides immediate outcomes for at-risk households, many of whom face high energy burdens.
- **Selective electrification of heat:** Cold-climate heat pumps can begin replacing oil heating where hydroelectric capacity is available. In partial-hydro communities, weatherization should come first,

followed by targeted heat-pump installations in homes best suited for the technology. This phased approach reduces emissions without increasing reliance on petroleum-based electricity.

- **Community-based delivery:** Partnering with regional housing authorities, tribal organizations, and local nonprofits ensures program access even in areas with limited internet connectivity. In this way, building energy improvements can reach those most in need while also supporting local job creation.

### Electricity Generation and Grid Resilience

Electricity-related emissions stem entirely from petroleum-fired generation, even though hydro already supplies a substantial share of power. This reliance on diesel and petroleum creates both high emissions and economic vulnerability.

- **Expand renewable generation:** Adding more hydro, wind, and solar generation reduces the region's dependence on petroleum while improving energy security. Renewable projects also reduce exposure to volatile fuel prices and shipping disruptions.
- **Upgrade microgrids:** Investments in distribution upgrades, controls, and storage enable communities to integrate renewables and reduce diesel runtime. These system-level improvements pave the way for electrification of heat and transport, ensuring those investments deliver actual emissions reductions.
- **Modernize remaining diesel assets:** Even with new renewable capacity, diesel generators will remain part of the system for reliability. Efficiency improvements, emissions controls, and waste-heat recovery can minimize emissions and improve performance.

### Workforce Development and Local Access

For any of these strategies to succeed, there must be a skilled workforce available to deliver them. At the same time, residents must be able to access programs without significant barriers.

- **Local training pipelines:** Expanding training for energy auditors, weatherization crews, and heat-pump installers strengthens community capacity and creates stable jobs. These investments anchor economic development in rural Southeast while reducing reliance on outside contractors.
- **Access supports:** Enrollment pathways that do not require broadband—such as in-person sign-ups, paper forms, and phone-based assistance—make programs more accessible to at-risk households. This ensures the benefits of mitigation strategies reach those most burdened by high costs and poor housing conditions.

### Improved Outcomes for Overburdened and Underserved Communities

Residents of the Prince of Wales/Kake region face high poverty rates, limited internet access, significant energy burdens, and elevated rates of disability and chronic illness. These challenges mean that sustainability and energy strategies must do more than reduce emissions—they must also deliver tangible improvements in daily life for vulnerable households.

Weatherization, efficient heating upgrades, and expanded renewable generation lower monthly energy costs, creating budget relief for families already under financial strain. At the same time, reducing reliance on fuel oil improves indoor air quality and housing conditions, which can ease respiratory and cardiovascular health risks. More resilient homes and local renewable power also provide protection against fuel supply disruptions and extreme weather, a growing concern for vulnerable households.

Finally, community-based delivery and local workforce training ensure that at-risk residents can fully participate in and benefit from these initiatives. By building local skills and offering offline enrollment options, programs expand access, generate employment, and strengthen self-reliance. In this way, mitigation strategies become not only pathways to lower emissions but also investments in health, affordability, and resilience for those most affected by environmental and energy challenges.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

| Strategy                                                 | Benefits                                                                                                                                                     | Disbenefits                                                                                                                                             | Community Benefits                                                                                                                                        |
|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Transportation (Idle Reduction, Fleet Optimization, EVs) | Fuel savings 5-10% in fleets; EVs cut CO <sub>2</sub> e 60-80% in hydro areas; lower freight costs and improved air quality for communities.                 | High upfront EV and charging costs; risk of unequal adoption if incentives don't reach low-income households.                                           | Lower goods costs, better air quality, reduced health risks from asthma/heart disease; mobility options through fleet electrification in public services. |
| Building Energy Transition (Weatherization & Heat Pumps) | Weatherization reduces energy use 20-30%, saving hundreds annually; heat pumps cut emissions 30-50%; lower energy burdens and improved indoor air quality.   | High upfront costs for retrofits; electrification in petroleum-reliant grids may not reduce emissions; risk of cost shift to vulnerable households.     | Reduced household energy burdens; healthier homes for seniors and those with chronic illness; improved affordability and resilience.                      |
| Electricity Generation & Grid Upgrades                   | Renewables reduce diesel runtime 20-40%; stable electricity pricing; improved resilience to supply disruptions; enables adoption of heat pumps and EVs.      | Capital-intensive; potential for ratepayer cost increases if financing is not structured equitably.                                                     | Stable utility costs, less exposure to fuel price spikes, more reliable power; resilience benefits especially for older adults and disabled residents.    |
| Workforce & Access Supports                              | Local workforce development creates skilled jobs; keeps 30-50% more project dollars circulating locally; improved access through offline enrollment options. | Requires upfront investment in training and supports (childcare, travel, tools); without supports, benefits may flow to already well-resourced workers. | Job creation pathways for vulnerable residents; economic resilience through local reinvestment; program access without internet reliance.                 |





### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- **Reduced household costs:** Weatherization, efficiency, and renewable power lower monthly utility bills and transportation expenses, easing financial strain.
- **Improved health outcomes:** Less reliance on fuel oil and gasoline reduces indoor and outdoor air pollution, helping address elevated asthma, heart disease, and other chronic illnesses.
- **Greater resilience:** More efficient homes, stable electricity pricing, and diversified power sources reduce vulnerability to extreme weather and fuel supply disruptions.
- **Local job creation:** Training and employing residents in energy and construction fields creates pathways to skilled employment and keeps dollars circulating in the local economy.
- **Inclusive program access:** Community-based delivery and offline enrollment options ensure households without internet or with limited mobility can still participate.

Potential disbenefits if not designed equitably:

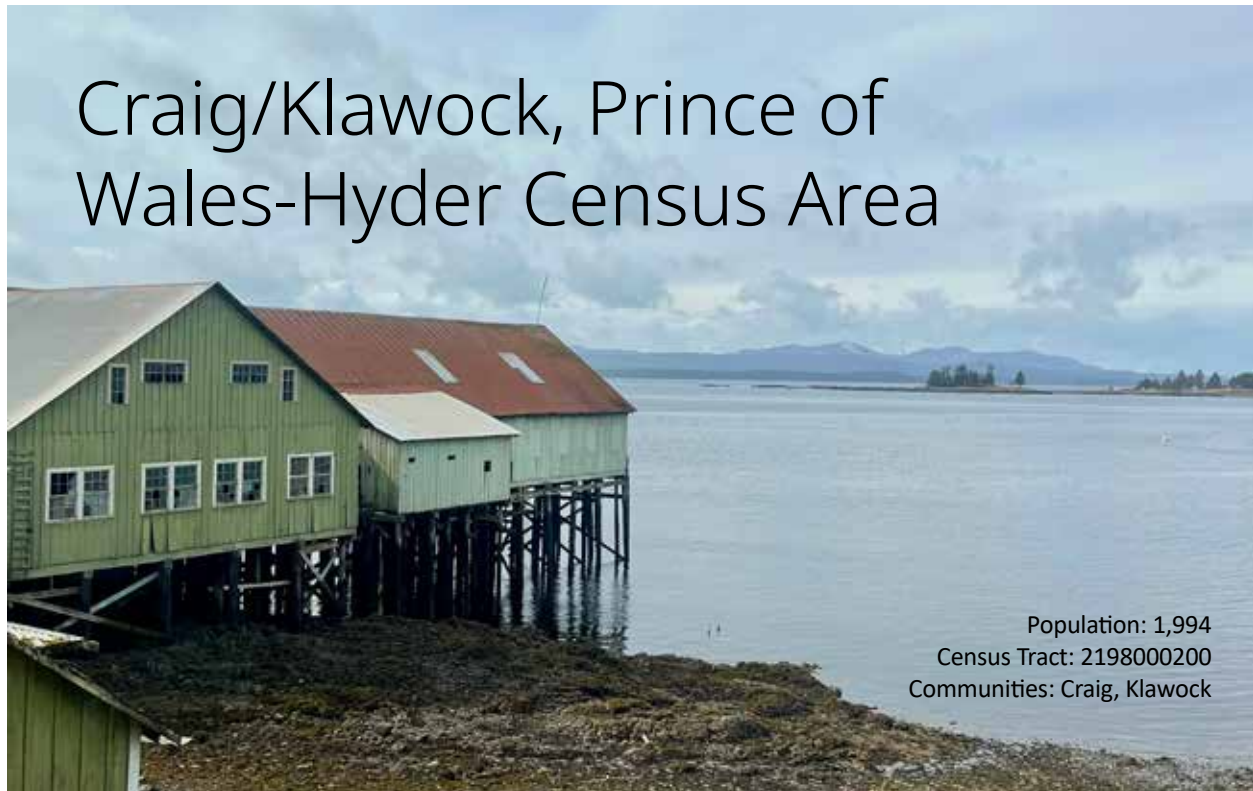
- **Upfront cost risks:** Without subsidies, weatherization, heat pumps, or EV adoption may be unaffordable for low-income households, widening inequities.
- **Cost-shifting potential:** Large-scale grid or generation projects could raise rates in the short term if financing is not structured equitably.
- **Uneven adoption:** Higher-income households and businesses may capture early benefits, while at-risk residents lag behind unless outreach and program design are intentional.
- **Capacity barriers:** Limited local contractor and workforce capacity could delay access to upgrades in vulnerable communities, especially remote areas.

### Path Forward

Across sectors—transportation, building energy, and electricity generation—the evidence suggests that well-designed mitigation strategies can deliver significant co-benefits for at-risk communities. Reduced household costs, healthier homes, and more resilient energy systems are direct gains that address the inequities highlighted in the region’s social determinants of health. However, risks such as upfront cost barriers, uneven program adoption, and short-term rate increases must be anticipated and managed through targeted subsidies, inclusive program design, and strong local workforce development.

In short, if implemented thoughtfully, these strategies not only move the region toward lower emissions but also help ensure that the energy transition becomes a vehicle for improved well-being and resilience among those most burdened by high costs and environmental stressors. This alignment between sustainability action and community benefit is essential for building durable support and achieving equitable outcomes in the Prince of Wales/Kake region.





The Craig/Klawock region, in the Prince of Wales–Hyder Census Area, faces a unique convergence of environmental, economic, and health challenges that directly shape its environmental and energy future. With total modeled emissions of over 61,000 metric tons CO<sub>2</sub>e, the region’s largest contributors are transportation (53.8%) and stationary combustion (46.2%), underscoring its dependence on fossil fuels for mobility, heat, and power. Older, inefficient housing, reliance on imported fuels, and limited healthcare and economic opportunities intensify the daily burden for residents. At the same time, the area’s cultural reliance on subsistence resources highlights the need for strategies that protect ecosystems and livelihoods.

Within this context, the most impactful mitigation opportunities have been identified: residential heating transition, transportation modernization, and energy efficiency/weatherization. These strategies not only target the largest emission sources but also align directly with community priorities by lowering household energy costs, improving health outcomes, and strengthening resilience to economic and environmental shocks. In short, emissions reduction in the Craig/Klawock region cannot be addressed in isolation; it must be integrated into a broader vision for affordable, healthy, and sustainable community life.

### Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Residential Heating Transition (Fuel Oil → Heat Pumps / Biomass)
2. Transportation Modernization (Trucks & Ferries)
3. Energy Efficiency & Weatherization (Homes & Public Buildings Priority)

These three strategies—heating transition, transportation modernization, and energy efficiency/weatherization—represent the highest leverage points. They directly target the largest emissions sectors while producing tangible, immediate co-benefits for at-risk communities: lower costs, improved health, and greater resilience.

## Emissions Data Overview

Note that the Price of Wales-Hyder Census area contains three census tracts. The modeled emissions data are for the entire area.

Total Modeled Emissions: 61,723 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (46.24%)

- Residential (27.15% of total)
  - Electricity: 4,731.52 mt CO<sub>2</sub>e (7.67%)
  - Natural Gas: 277.31 mt CO<sub>2</sub>e (0.45%)
  - Propane: 750.16 mt CO<sub>2</sub>e (1.22%)
  - Residual Fuel Oil No. 5: 10,691.36 mt CO<sub>2</sub>e (17.32%)
  - Wood & Wood Residuals: 305.42 mt CO<sub>2</sub>e (0.49%)
- Commercial Sector (17.85%)
  - Electricity: 6,550.47 mt CO<sub>2</sub>e (10.61%)
  - Distillate Fuel Oil No. 1: 4,852.23 mt CO<sub>2</sub>e (7.86%)
  - Propane: 370.42 mt CO<sub>2</sub>e (0.60%)
  - Wood & Wood Residuals: 13.47 mt CO<sub>2</sub>e (0.02%)
- Industrial Sector: 0%. Solid waste and wastewater emissions were not included in this dataset.

### Transportation (53.76%)

- Motor Gasoline (main contributor • 26,433.32 mt CO<sub>2</sub>e (42.83%)
- Diesel Fuel: 6,746.78 mt CO<sub>2</sub>e (10.93%)
- Electricity (vehicles): 0.73 mt CO<sub>2</sub>e (negligible)

In terms of vehicle types:

- Trucks: 30,523.68 mt CO<sub>2</sub>e (91.99%)
- Passenger vehicles: 2,613.62 mt CO<sub>2</sub>e (7.88%)
- Motorcycles: 43.54 mt CO<sub>2</sub>e (0.13%)

### Electricity Generation

- Total electricity consumption: 51,547.53 MWh
  - Petroleum-fueled generation: 39,176.12 MWh → 11,282.72 mt CO<sub>2</sub>e (100%)
  - Hydro 12,371.41 MWh → 0.00 mt CO<sub>2</sub>e (0.00%)

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use):

- Not included in this dataset

### Key Takeaways

- Transportation dominates emissions (53.8%), especially trucks powered by gasoline.
- Stationary combustion is significant (46.2%), with residential fuel oil (No. 5) at 17.3% and commercial electricity at 10.6%.
- Electric generation contributes 15.5% of emissions—despite substantial hydro use, all emissions come from petroleum-fired generation.



## Social Determinants of Health

### Environmental Conditions

- Geographic isolation and dispersed communities: Settlements are spread across islands and are primarily accessible by boat or plane.
- High reliance on diesel for heat and power: Most communities depend on imported fuels for basic energy needs.
- Older, inefficient housing stock: Many homes have poor insulation and ventilation, increasing heating demands.
- Subsistence reliance on land and sea resources: Hunting, fishing, and gathering remain central to food security and cultural identity.

Implications: The region's heavy dependence on fossil fuels, inefficient housing, and transportation challenges create both high costs and high emissions. At the same time, the importance of subsistence livelihoods means that pollution reduction strategies must protect local ecosystems. Renewable integration, housing retrofits, and transport improvements could yield strong co-benefits, but must overcome cost and logistical barriers.

### Public Health Indicators

- Limited healthcare access: Residents rely on small clinics, and specialized care requires long-distance travel.
- Higher rates of chronic disease: Conditions such as diabetes, heart disease, and respiratory illness occur at higher-than-average levels.
- Vulnerability to environmental health impacts: Diesel exhaust, mold in older housing, and wildfire smoke exacerbate existing health risks.

Implications: Health outcomes are closely linked to environmental exposures, and limited local healthcare capacity heightens community vulnerability. Pollution reduction is therefore not only an environmental goal but a preventive health measure that could alleviate chronic disease burdens and improve resilience to environmental stressors.

### Socioeconomic Factors

- Elevated poverty rates and limited employment: Households often face economic insecurity, with jobs concentrated in fishing, timber, and tourism.
- Lower educational attainment: Limited higher education opportunities contribute to outmigration and workforce challenges.
- High cost of living due to fuel import dependence: Transportation and heating expenses consume a large share of household budgets.
- Strong Indigenous representation: Alaska Native communities play a central role in cultural and economic life.

Implications: Financial and workforce limitations constrain the ability of households and communities to adopt sustainability solutions without support. However, reducing reliance on expensive imported fuels could lower living costs, while training programs and culturally informed approaches could ensure broader participation in pollution reduction strategies.

### Intersection with Emissions Reduction Planning

- Multiple co-benefits are possible: Addressing fossil fuel dependence, inefficient housing, and limited healthcare access could simultaneously reduce emissions, lower costs, and improve health outcomes.
- Equity is essential: Because poverty and limited resources restrict household capacity to act, state-level planning must ensure that sustainability programs are accessible, affordable, and responsive to local conditions.



- Cultural context matters: The strong Indigenous presence underscores the need to design pollution reduction measures in ways that respect subsistence practices and traditional ecological knowledge.
- Geography defines feasibility: Isolation, transportation costs, and small population scale mean solutions must be tailored rather than one-size-fits-all.

**Implications:** The region's environmental, health, and socioeconomic realities mean that emissions reduction cannot be treated as a separate policy domain. Instead, it must be integrated into broader efforts to improve living conditions, strengthen community resilience, and protect cultural lifeways. Framing pollution reduction as a pathway to healthier, more affordable, and more secure communities will likely resonate most strongly in this region.

## Mitigation Strategies

### Transportation

Transportation is the largest source of emissions in the region, accounting for more than half of total CO<sub>2</sub>e. Trucks dominate this profile, generating more than 90% of transportation emissions. Given the region's geography—scattered communities connected by ferries, boats, and limited road systems—transportation is also central to daily life.

- Fleet modernization and efficiency: Supporting a gradual shift from older, high-emitting gasoline trucks to more efficient vehicles could bring significant reductions. While electrification faces challenges due to grid constraints, hybrid and efficient diesel/gasoline technologies are intermediate opportunities.
- Marine and ferry system improvements: Targeting ferries and other community vessels for electrification or hybridization would cut fuel costs and emissions simultaneously, aligning with state priorities on transportation electrification.
- Mobility alternatives: In places where feasible, shared transport systems and active transport options could reduce per-capita reliance on individual high-emission vehicles.

Addressing transportation emissions could improve air quality and reduce costs of imported fuels, while also enhancing mobility for at-risk communities who face higher barriers to owning and maintaining reliable vehicles.

### Energy Transition in Buildings

Stationary combustion makes up nearly half of emissions, with residential use of fuel oil No. 5 being the largest single stationary source. Electricity generation also remains carbon-intensive where petroleum-fired power supplements hydro.

- Residential heating transition: Phasing out residual fuel oil No. 5 in favor of electric heat pumps or biomass systems could directly cut household costs and emissions. Retrofits targeting older housing stock would be especially impactful for vulnerable households burdened by high fuel bills.
- Community-scale renewable integration: Expanding hydro capacity and pairing it with solar or wind would allow for greater displacement of diesel and fuel oil generation. The state plan prioritizes microgrid innovation, which fits the geographic isolation of this region well.
- Energy efficiency retrofits: Upgrading insulation, windows, and ventilation in existing homes and public buildings reduces both heating demand and health risks (e.g., mold, indoor air pollution).

An energy transition rooted in efficiency and renewable adoption can reduce financial strain on households, lower exposure to pollutants, and improve resilience for communities otherwise dependent on volatile fuel imports.

### Built Environment & Housing

Housing is both a driver of stationary emissions and a determinant of health outcomes. Many structures are inefficient and expensive to heat, contributing to both poverty burdens and chronic health stressors.

- Weatherization and retrofit programs: Scaling state-supported weatherization for at-risk households would achieve dual goals: reducing emissions from heating and improving indoor health.
- Community facility upgrades: Schools, clinics, and public buildings can serve as demonstration sites for high-performance energy systems, anchoring broader community adoption.

Investing in the built environment directly addresses multiple vulnerabilities—energy burden, respiratory health, and emissions—while creating local jobs tied to retrofit and construction work.

### Health and Community Resilience

The region faces high rates of chronic disease, limited healthcare access, and vulnerability to environmental stressors. Mitigation efforts can produce immediate health gains if they reduce local pollution and stabilize household energy.

- Indoor air quality improvements: Transitioning away from diesel and fuel oil heating reduces particulate exposure, improving respiratory outcomes.
- Lower household energy burdens: Efficiency and renewable energy programs reduce the share of income spent on heating and fuel, improving economic security for vulnerable households.
- Alignment with subsistence culture: Protecting fisheries, wildlife, and forests through reduced pollution directly supports food security and cultural lifeways.

Emissions reduction strategies are inseparable from health equity in this region. For at-risk households, every ton of reduced emissions also represents reduced financial stress and improved living conditions.

### Improved Outcomes for Overburdened and Underserved Communities

Implementing the priority mitigation strategies—residential heating transition, transportation modernization, and energy efficiency and weatherization—offers direct and meaningful benefits. By replacing fuel oil heating with efficient alternatives, families will see lower monthly energy bills and healthier indoor environments, reducing risks of respiratory and cardiovascular illness. Modernizing transportation, including trucks and ferries, lowers the cost of travel and improves access to jobs, healthcare, and education, addressing persistent mobility challenges for households without reliable vehicles. Expanded weatherization and efficiency programs further reduce household energy burdens while improving the safety and comfort of older housing stock disproportionately occupied by at-risk residents. Together, these measures not only reduce emissions but also create healthier, more affordable, and more resilient living conditions, ensuring that sustainability actions delivers immediate and tangible improvements for those most affected by economic and health disparities.



**Benefit (Disbenefit) Quantification or Qualitative Analysis**

| Strategy                                                          | Benefits                                                                                  | Disbenefits                                                                                   | Community Benefits                                                                                                  |
|-------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Transportation Modernization (Trucks, Ferries, Shared Mobility)   | Reduces largest emission source; lowers fuel costs; improves regional connectivity.       | High upfront costs for fleet replacement; infrastructure limits (charging, ferry retrofits).  | Improves mobility for vulnerable households; risk of inequity if programs favor wealthier adopters.                 |
| Residential Heating Transition (Fuel Oil to Heat Pumps/Biomass)   | Cuts major stationary source emissions; reduces heating costs; lowers pollution exposure. | Upfront installation costs; reliability concerns in extreme cold; biomass supply chain needs. | Reduces energy burden; lowers indoor pollution exposure; greatest benefit for fuel-dependent low-income households. |
| Community-Scale Renewable Energy (Hydro, Solar, Wind, Microgrids) | Displaces petroleum-based electricity; improves energy security; stabilizes prices.       | High capital investment; intermittency challenges; long project timelines.                    | Increases resilience of remote communities; reduces reliance on imported fuels.                                     |
| Energy Efficiency Retrofits (Homes & Public Buildings)            | Reduces household energy demand; lowers costs; improves comfort and safety.               | Requires skilled labor; upfront investment; limited contractor availability.                  | Reduces utility bills; improves housing quality for low-income residents; co-benefits for health.                   |



### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- **Reduced energy burden:** Lower heating, electricity, and transportation costs relieve financial stress for low-income households.
- **Improved housing quality:** Weatherization and retrofits improve comfort, safety, and indoor air quality in older housing stock disproportionately occupied by vulnerable residents.
- **Better health outcomes:** Reductions in fuel oil and diesel combustion lower exposure to particulates, improving respiratory and cardiovascular health.
- **Enhanced resilience:** Community-scale renewables and efficiency upgrades reduce reliance on imported fuels, providing stability during supply disruptions that most affect vulnerable communities.
- **Local economic opportunities:** Workforce development in clean energy and retrofits creates jobs accessible to underemployed residents, building long-term capacity.
- **Mobility equity:** Transportation improvements enhance access to healthcare, education, and jobs for households with limited vehicle ownership or unreliable older vehicles.
- **Cultural protection:** Pollution reduction safeguards fisheries, forests, and wildlife that sustain Indigenous lifeways and food security.

Potential disbenefits if not designed equitably:

- **High upfront costs:** Without subsidies, vulnerable households may be excluded from adopting new technologies (vehicles, heat pumps, solar).
- **Access inequities:** Programs that lack targeted design risk being taken up first by higher-income households, widening disparities.
- **Capacity constraints:** Limited contractors and workforce shortages could delay implementation in rural and remote communities.
- **Program complexity:** Application processes for incentives or weatherization programs can be difficult for households with limited administrative resources.
- **Interim disruptions:** Infrastructure changes (e.g., ferry retrofits, housing upgrades) may temporarily increase costs or reduce service reliability, which disproportionately affects vulnerable residents.

### Path Forward

The Craig/Klawock region can make the greatest near-term impact by advancing three high-benefit strategies: transitioning residential heating away from fuel oil, modernizing transportation systems, and scaling up energy efficiency and weatherization. These approaches directly target the largest sources of emissions while also reducing household energy costs, improving health outcomes, and strengthening resilience against volatile fuel prices. By starting here, the region can demonstrate meaningful progress on emissions reduction while improving daily life for residents, particularly low-income and overburdened households.

Successful implementation will depend on community-based delivery and long-term capacity building. Tribal governments, local organizations, and regional partners will be essential to ensure programs are culturally appropriate and accessible, while targeted subsidies and simplified enrollment processes will help at-risk households benefit first. Over time, investment in local workforce development and community-scale renewable generation can reduce reliance on imported fuels and create lasting economic opportunities. Taken together, these steps provide a pathway for the Craig/Klawock region to align sustainability actions with affordability, health, and resilience, ensuring that pollution reduction becomes a driver of stronger, more self-reliant communities.



# Downtown Sitka, Sitka Borough



Sitka: By VermontPowderKing, wikimedia

Population: 5,020  
Census Tract: 2220000200

Downtown Sitka sits at the intersection of environmental vulnerability, community health challenges, and the urgent need to reduce criteria pollutants and gas emissions. The region's emissions profile reveals that the vast majority of emissions stems from two primary sources: heating oil use in buildings and fuel consumption in transportation, particularly freight. At the same time, Sitka's social determinants of health data highlight elevated rates of chronic disease, high household energy burdens, older housing stock, and disproportionate risks many populations. These overlapping conditions mean that strategies to cut emissions must also strengthen resilience, lower costs, and improve health outcomes for the community's most at-risk residents.

This roadmap identifies the strategies with the greatest potential to deliver meaningful reductions in emissions while addressing local needs. By focusing on building heating transitions, freight and fleet modernization, and community facility retrofits, Sitka can achieve significant sustainability benefits and simultaneously improve daily life for its residents. These strategies not only reduce reliance on polluting fuels but also offer co-benefits in the form of cleaner air, healthier housing, lower energy bills, and stronger community infrastructure. Centering the outcomes for at-risk households ensures that the path to decarbonization also advances equity, resilience, and shared prosperity.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Building Heating Oil Transition to Electric Heat (Heat Pumps + Weatherization)
2. Freight & Fleet Transition (Diesel-to-Electric / Low-Emission Trucks)
3. Public & Community Facility Retrofits (Electrification + Efficiency)

Taken together, these three strategies directly target Sitka's two largest sources of emissions (buildings and transport) while simultaneously producing the strongest co-benefits for health, energy affordability, and resilience.

## Emissions Data Overview

Note that these data are for the entire Census Area, which contains two Census Tracts.

Total Modeled Emissions: 47,780 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined. (total population of 8,063)

### Stationary Combustion (68.27%)

- Residential Sector (50.70%)
  - Residual Fuel Oil No. 5: 22,557.45 mt CO<sub>2</sub>e (~ 47.21% of total)
  - Propane: 833.51 mt CO<sub>2</sub>e (~ 1.74%)
  - Natural Gas: 774.15 mt CO<sub>2</sub>e (~ 1.62%)
  - Wood/Wood Residuals: 60.23 mt CO<sub>2</sub>e (~ 0.13%)
- Commercial Sector (17.57%)
  - Distillate Fuel Oil No. 1: 7,778.05 mt CO<sub>2</sub>e (~ 16.28%)
  - Propane: 593.77 mt CO<sub>2</sub>e (~ 1.24%)
  - Wood/Wood Residuals: 21.59 mt CO<sub>2</sub>e (~ 0.05%)
- Industrial Sector
  - 0% (no industrial stationary emissions in this model)

### Transportation (31.73%)

Fuel types:

- Motor Gasoline: 12,888.56 mt CO<sub>2</sub>e (~ 26.97%)
- Diesel Fuel: 2,273.19 mt CO<sub>2</sub>e (~ 4.76%)

Vehicle types (share of transportation emissions):

- Trucks: 13,231.13 mt CO<sub>2</sub>e (~ 87.27%)
- Passenger vehicles: 1,916.84 mt CO<sub>2</sub>e (~ 12.64%)
- Motorcycles: minimal (13.78 mt CO<sub>2</sub>e, ~ 0.09%)

### Electricity Generation

- Electricity consumption: 120,398.84 MWh
- Generation sources:
  - Hydro: 120,398.84 MWh → 0.00mt CO<sub>2</sub>e

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- The vast majority of emissions (≈ 68%) come from stationary combustion (buildings, heating, etc.), and within that, a large single fuel type—Residual Fuel Oil dominates.
- Transportation is a significant source (≈ 32%). While passenger vehicles make up most of the vehicles in Sitka, emissions in this model are especially dominated by gasoline use in trucks (heavy/medium duty).
- Local electricity generation does not contribute to emissions in this inventory; the grid is supplied via non-emitting sources (hydropower).



St. Michael's Cathedral: By Robert Pernet, wikimedia

## Social Determinants of Health

### Environmental Conditions

- Extreme Weather & Disaster Risk
  - Anticipated changes in extreme weather: 44.32 percentile
  - Annualized disaster loss: 62.50 percentile, equivalent to \$1.18M annually
  - Flood risk: 15% of properties, 77th national percentile
  - Airport proximity: 92.44%, raising exposure to emissions and noise
- Pollution & Exposure Risks
  - Diesel particulate matter exposure: 0.04 (low but relevant in a marine/transport hub)
  - Air toxics cancer risk: 9.0 (notably high)
  - Hazardous sites proximity: 66.48 percentile
  - RMP facility proximity: 90.91 percentile, indicating high risk from regulated chemical facilities
  - Pre-1980s housing: 82.95 percentile, elevating lead/asbestos risks
  - Toxic releases: 0 percentile (limited industrial emissions reported)

Implications: Sitka's downtown faces elevated disaster and flood risks, along with notable exposure to hazardous sites and aging housing stock, which heighten vulnerability to pollution-related illnesses. These environmental pressures compound existing social and health challenges, emphasizing the need for forward-looking planning that strengthens infrastructure, protects residents, and reduces environmental health risks.

### Public Health Indicators

- Chronic Health Conditions
  - Asthma: 9.3% (82.39 percentile)
  - Cancer: 6.3% (94.89 percentile)
  - High blood pressure: 31.8% (93.18 percentile)
  - Diabetes: 8.6% (90.34 percentile)
- Mental & General Health
  - Poor mental health prevalence: 12% (76.70 percentile)
  - Average life expectancy: 78.8 years (moderate, 47th percentile for low life expectancy)

Implications Statement: Chronic disease prevalence in Sitka is significantly above national averages, particularly for cancer, cardiovascular disease, and diabetes. Combined with notable mental health concerns, the population has reduced resilience to additional environmental stressors, such as pollution or environmental-related disasters.

### Socioeconomic Factors

- Poverty & Inequality
  - Below 200% Federal Poverty Level (FPL): 21.4% (42.61 percentile)
  - GINI index: 0.42 (68.18 percentile)
  - Median home value: \$349,500 (76 percentile)
  - Energy burden: 4% of annual costs (77 percentile)
- Education, Employment, and Insurance
  - No high school diploma: 4.9% (32.67 percentile)
  - Unemployment: 3.8% (45.17 percentile)
  - Uninsured: 14.5% (58.52 percentile)
  - Lack of internet access: 20.1% (76.14 percentile)
- Housing & Demographics
  - Renters: 44.2% (73.3 percentile)
  - Housing cost burden: 29% (61.93 percentile)

- Population 65+: 17.1% (90.34 percentile)
- Disability prevalence: 13% (55.4 percentile)

**Implications:** Sitka exhibits high housing costs, renter burden, and energy burdens, along with elevated senior population and income inequality. Limited internet access adds to social vulnerability, especially for access to health and emergency information. These conditions increase inequities in who is most affected by environmental and pollution stressors.

### Transportation Insecurity

- Access & Affordability
  - Transportation access score: 0.22 (62.5 percentile)
  - Cost burden: 0.13 (53.76 percentile)
  - Traffic fatalities: 0 (0 percentile)

**Implications:** While Sitka benefits from low traffic fatality risks, transportation access remains limited and costs are moderate. Dependence on ferries, air travel, and limited road networks highlight vulnerability to disruptions caused by fuel prices or extreme weather events.

### Intersection with Emissions Reduction Planning

- High Health Burdens: The elevated prevalence of cancer, asthma, and cardiovascular disease means reducing local pollution could yield direct health benefits, lowering healthcare burdens.
- Vulnerable Housing Stock & Infrastructure: Older housing and renter concentration increase risks from extreme weather and energy costs, making equitable energy efficiency retrofits essential.
- Economic & Social Inequities: High energy burdens and inequality suggest that pollution reduction strategies must prioritize affordability and equity, ensuring low-income households and seniors benefit.
- Disaster & Exposure Risks: With flood-prone areas and hazardous site proximity, sustainability plans must align with resilience and hazard mitigation to avoid compounding risks.
- Transportation Dependence: Limited access and reliance on air/marine transport means decarbonization strategies must balance mobility needs with resilience, avoiding disproportionate impacts on isolated communities.





## Mitigation Strategies

### Buildings & Heating Transition

The emissions profile shows that the single largest source of criteria pollutants and greenhouse gas emissions in the Sitka Census Area is stationary combustion in buildings, dominated by the use of Residual Fuel Oil No. 5 for heating. This is compounded by the fact that downtown Sitka has a high share of pre-1980s housing, much of it renter-occupied, which increases vulnerability to both health and energy cost burdens. Transitioning buildings toward electrified heating (heat pumps), insulation upgrades, and weatherization would have outsized environmental and health benefits.

- **Core Strategy:** Scale up residential and commercial heating oil conversion programs, prioritizing at-risk households in older housing stock.
- **Co-benefits:** Improves indoor air quality, reduces asthma triggers, and lowers household energy burdens.
- **Health Link:** By reducing exposure to heating oil emissions, the community can mitigate chronic conditions already prevalent (asthma, heart disease, and cancer).

### Transportation Emissions Reduction

Transportation is the second-largest emissions source, with trucks and freight dominating the sector. Barges, boats, and aircraft play a critical role in moving cargo and people. Although their emissions are not captured in the current inventory, they likely play a significant role in emissions. Downtown Sitka, as a hub for goods movement and services, bears a disproportionate share of this burden. Residents already face elevated risks from diesel particulate exposure and higher rates of respiratory illness.

- **Core Strategy:** Electrify local road fleets where feasible, explore hybrid systems or low-carbon fuel options for trucks, marine vessels, and aircrafts; expand public and shared mobility options to reduce reliance on private vehicles.
- **Supplementary Measures:** Expand active transportation infrastructure (safe walking/biking routes) in downtown, improving mobility access for seniors and residents without cars.
- **Health Link:** Reducing truck diesel use directly lowers air toxics and cancer risks. Enhancing mobility options reduces transportation insecurity, which was noted as a challenge in the tract data.

### Energy Efficiency & Resilience

The energy burden in Sitka (77th percentile nationally) highlights the disproportionate strain that energy costs place on residents, especially renters and low-income households. Because the electric grid is supplied by hydropower (zero emissions), efficiency gains and electrification represent not only sustainability benefits but also financial relief.

- **Core Strategy:** Deploy comprehensive energy efficiency retrofits for homes and community facilities, focusing on high-burden households.
- **Resilience Integration:** Link upgrades to hazard resilience—such as weatherproofing against floods and storms—to address disaster loss risks (already high in Sitka).
- **Health Link:** Reduced energy burdens translate into greater financial stability, while resilient housing stock reduces displacement and health risks during disasters.

### Community Health & Environmental Risk

Sitka's population exhibits high prevalence of chronic disease (diabetes, cancer, hypertension) compared to national levels. Exposure to hazardous sites (90th percentile RMP facility proximity) and flood risks compound these vulnerabilities. Emissions reduction strategies that integrate community health interventions will deliver outsized benefits.

- **Core Strategy:** Tie pollution reduction planning to community health services—for example, integrating asthma care programs with housing retrofit initiatives.

- **Supplementary Measures:** Prioritize air quality monitoring and public reporting, especially near freight corridors and hazardous facilities, to reduce environmental health disparities.
- **Health Link:** This direct linkage of environmental and health strategies improves outcomes for communities most burdened by overlapping risks.

### Localized Adaptation & Hazard Reduction

Downtown Sitka's flood risk (77th percentile nationally) and high disaster loss exposure underscore the need for strategies that are not only emission-reducing but also risk-reducing. Formerly used defense sites and hazardous waste proximity increase the consequences of environmental disasters.

- **Core Strategy:** Combine green infrastructure and flood resilience measures with emissions reductions. For example, resilient waterfront and stormwater improvements can reduce disaster risks while lowering fossil fuel use in construction and operations.
- **Health Link:** Protecting housing and community assets ensures stability for vulnerable populations and reduces post-disaster health and economic fallout.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes for at-risk populations in Sitka are closely tied to strategies that address both emissions and social determinants of health. By prioritizing building retrofits and heating fuel transitions in older, renter-occupied housing, these households can experience reduced exposure to indoor and outdoor air pollutants, directly lowering risks of asthma, cardiovascular disease, and cancer that are already disproportionately high in the region. At the same time, efficiency upgrades and electrification will cut household energy burdens—freeing up limited incomes for food, healthcare, and other essentials. This combination of cleaner air and lower costs provides a tangible pathway to improved health and economic stability.

On the transportation side, reducing diesel emissions from freight and delivery trucks not only cuts a significant portion of Sitka's criteria pollutants and greenhouse gas emissions but also improves air quality in neighborhoods closest to busy corridors—areas where at-risk residents are often concentrated. Enhanced public and active transportation options expand mobility for those without reliable vehicle access, helping seniors, youth, and low-income households better reach jobs, healthcare, and education. Coupled with resilience upgrades to housing and community infrastructure, these strategies ensure that at-risk households are not only protected from the worst environmental disasters but also share in the health, financial, and social benefits of the transition. Ultimately, placing fair outcomes at the center of Sitka's sustainable energy action reduction plan ensures that the region's most vulnerable residents are healthier, more resilient, and better able to thrive in a changing environment.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Buildings & Heating Transition (heat pumps + weatherization; fuel oil → electric)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                      | Community Benefits                                                                                                                   |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Buildings are the region's largest source via heating oil. Electrifying space/water heat plus weatherization can reduce ~3–4 tCO <sub>2</sub> e/home/year (typical cold-climate heat-pump swap) and 50–70% of building emissions at scale. | Prioritize older/renter housing and high-burden blocks for largest per-\$ benefits.                                                  |
| Energy cost savings | High             | In hydro-powered towns like Sitka, heat pumps often cut heating spend by \$1,200–\$1,800 per home/yr after envelope fixes; public/commercial retrofits often save 15–30% on bills.                                                         | Reduces energy burden (already elevated); frees income for food/health; renters need protections to share benefits.                  |
| Health benefits     | High             | Lower indoor NO <sub>x</sub> /PM and outdoor oil combustion; fewer asthma triggers; better thermal comfort; moisture/mold mitigation with envelope fixes.                                                                                  | At-risk households have higher disease burdens—direct air-quality and indoor-environment wins.                                       |
| Resilience          | Moderate–High    | Tighter envelopes keep homes habitable during outages; less reliance on fuel deliveries; potential to pair with backup heat or thermal storage.                                                                                            | Helps households most at risk from outages and freight delays; reduces emergency displacement.                                       |
| Disbenefits / risks | Moderate         | Upfront costs; contractor capacity; winter performance if under-sized; landlord-tenant split; panel/electrical upgrades; potential grid peaks without controls.                                                                            | Avoid cost pass-throughs to renters; offer no-cost programs, on-bill tariffs, tenant protections; target workforce training locally. |



Sitka High School: By Jonathan.s.kt, wikimedia

**Transportation Emissions Reduction (fleet & freight efficiency, EVs/EVSE, active mobility)**

| Outcome             | Potential Impact         | Quantitative / Qualitative Assessment                                                                                                                                                             | Community Benefits                                                                                        |
|---------------------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High            | Transport is ~⅓ of area emissions; truck/freight dominates. Per light-duty EV: ~2–4 tCO <sub>2</sub> e/year avoided (mileage-dependent); medium/heavy trucks yield larger per-vehicle reductions. | Cut exposures in freight-affected corridors; prioritize last-mile fleets that operate in at-risk areas.   |
| Energy cost savings | Moderate                 | EV total cost of ownership typically lower; public fleets save on fuel/maintenance; routing/idle-reduction for trucks adds 5–15% fuel savings.                                                    | Lower transport costs benefit low-income workers if shared mobility and transit are expanded.             |
| Health benefits     | High (corridor-specific) | Diesel PM and toxics reductions near docks/depots/delivery routes; fewer cold-start emissions; noise reductions.                                                                                  | Strongest near at-risk neighborhoods adjacent to busy truck routes; design anti-displacement protections. |
| Resilience          | Moderate                 | Diversifies away from fuel price shocks; local electricity is hydro-based; requires charging resilience and winterization.                                                                        | Site charging in at-risk areas to avoid “charging deserts”; include cold-weather reliability.             |
| Disbenefits / risks | Low–Moderate             | Charging access inequities; upfront fleet costs; grid impacts at depots; limited heavy-duty models; winter range loss.                                                                            | Prevent inequitable charger siting; support used-EV access and subsidies for low-income drivers.          |

**Public & Community Facilities Efficiency (schools, clinics, municipal buildings)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                  | Community Benefits                                                                                 |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Typical projects deliver 15–30% energy cuts per facility; electrified boilers/heat can sharply reduce oil combustion in hydro regions. | Cuts emissions at community anchors serving at-risk residents (schools, clinics, shelters).        |
| Energy cost savings | High             | Large bills mean six-figure lifetime savings per building; savings can backstop services instead of fuel.                              | Savings stabilize services in community-serving facilities; helps avoid fee hikes or service cuts. |
| Health benefits     | Moderate–High    | Better IAQ/ventilation; thermal comfort; fewer diesel exhaust hotspots around facilities.                                              | Direct benefits to children, elders, and medically vulnerable using public buildings.              |
| Resilience          | High             | Facilities become resilient hubs (backup heat, tighter envelopes); can host community charging and sheltering.                         | Reliable safe spaces in outages matter most for at-risk communities.                               |
| Disbenefits / risks | Low–Moderate     | Construction disruption; capital needs; O&M for new systems.                                                                           | Phase projects to avoid service interruptions in community-serving facilities.                     |



**Community Health & Air-Quality Actions (monitoring, clinical tie-ins, home IAQ fixes)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                     | Community Benefits                                                                   |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| GHG reduction       | Low              | Minimal direct CO <sub>2</sub> impact; primarily enables/targets other measures.                                          | N/A directly; makes other measures more effective.                                   |
| Energy cost savings | Low–Moderate     | Targeted IAQ/efficiency kits (filters, sealing) yield small bill savings; biggest gains when bundled with weatherization. | Delivers quick wins for households awaiting major retrofits.                         |
| Health benefits     | High             | Reduced ER visits/exacerbations for asthma/CVD; risk communication during smoke/inversions; home hazard mitigation.       | High—addresses existing elevated disease burdens in at-risk homes first.             |
| Resilience          | Moderate         | Portable air cleaning, heat-safe rooms, and comms reduce harm during events.                                              | Prioritize medically vulnerable at-risk residents.                                   |
| Disbenefits / risks | Low              | Risk of one-off pilots without follow-through; data without action.                                                       | Ensure data triggers services in at-risk areas; avoid surveillance without benefits. |

**Localized Adaptation & Hazard Reduction (flood/stormwater; fuel-storage risk; green infra)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                           | Community Benefits                                                                                    |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate     | Direct CO <sub>2</sub> cuts are small; some measures (green infra, avoided diesel pumping) have minor reductions; main value is risk reduction. | Indirect—protects low-income housing from loss/damage that can entrench emissions-intensive recovery. |
| Energy cost savings | Low–Moderate     | Fewer outage losses and emergency fuel costs; better drainage reduces building damage/repair spend.                                             | Avoids catastrophic expenses that hit at-risk households hardest.                                     |
| Health benefits     | Moderate–High    | Less mold, contamination, displacement; safer outdoor air during events; reduced injury risk.                                                   | High—disasters disproportionately affect at-risk households.                                          |
| Resilience          | High             | Addresses flood-exposed parcels and hazardous-site proximity; reduces dependence on fuel deliveries; protects critical access.                  | Target first where at-risk housing overlaps risk zones.                                               |
| Disbenefits / risks | Moderate         | Construction impacts; potential rent increases near improved areas; maintenance burden.                                                         | Anti-displacement policies, affordability covenants, and local jobs training mitigate harms.          |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy costs → Reduces energy burden and frees up income for food, healthcare, and essentials.
- Improved indoor and outdoor air quality → Cuts asthma triggers, lowers cardiovascular and cancer risks, and supports healthier children and elders.
- More resilient housing and facilities → Provides safer shelter during disasters, reduces displacement risks, and protects medically vulnerable households.
- Expanded mobility options → Improves access to jobs, healthcare, and schools for households without reliable vehicles.
- Stabilized community services → Efficiency in schools, clinics, and public buildings lowers operating costs and strengthens resources relied on by at-risk residents.
- Local job creation → Workforce training for retrofits, electrification, and adaptation can create accessible jobs for vulnerable residents.

Potential disbenefits if not designed equitably:

- Upfront cost barriers → Without targeted subsidies, low-income households may be excluded from upgrades or face rent increases if landlords pass costs along.
- Risk of displacement → Building improvements or resilience investments may drive property values up, potentially pricing out renters in downtown Sitka.
- Access inequities → EV charging, retrofit programs, or incentive structures could bypass at-risk households if not designed for equitable participation.
- Program fatigue / complexity → Application processes, documentation burdens, or limited contractor availability may discourage participation.
- Reliability gaps → Electrification without proper resilience planning could leave vulnerable households exposed during outages or cold snaps.

### Path Forward

Sitka's emissions profile and health context make clear that the most impactful actions lie in addressing building heating, freight transportation, and community facility energy use. By pursuing electrification and efficiency in these areas, the community can achieve deep emissions reductions while delivering substantial co-benefits: lower household energy costs, improved indoor and outdoor air quality, healthier housing, and stronger community resilience. These gains are especially critical for at-risk households, who currently bear disproportionate health and financial burdens.

The path forward should begin with scaling up building heating oil transitions, targeting older and renter-occupied homes where the benefits will be most immediate. In parallel, strategic investments in fleet and freight electrification can reduce diesel pollution in downtown corridors while lowering long-term costs for operators. Finally, retrofitting schools, clinics, and municipal buildings can cut emissions, reduce public expenditures, and ensure safe, resilient spaces for residents during emergencies. Together, these strategies form a core foundation for Sitka's sustainable energy roadmap.

Future phases will need to define program design, financing mechanisms, workforce development, and adoption pathways to ensure that these strategies are achievable and sustainable. By aligning decarbonization priorities with community health and resilience goals, Sitka has the opportunity to demonstrate how sustainability action can directly improve daily life for its residents while safeguarding the future of the region.



The Sitka Census Area, including Outer Sitka, faces a unique intersection of opportunities and challenges in reducing criteria pollutants and greenhouse gas (GHG) emissions. The region's emissions profile shows a strong concentration in two sectors—stationary combustion for heating and transportation—together accounting for nearly all local emissions. At the same time, Sitka benefits from a distinct advantage: its electricity is supplied by non-emitting hydropower, providing a clean and stable foundation for electrification strategies.

Outer Sitka's social determinants of health further shape how emissions reduction measures will be experienced across the community. While residents enjoy relatively strong health outcomes and low baseline pollution exposure, they face elevated risks from high energy burdens, transportation insecurity, flood exposure, and the vulnerabilities of older housing stock. For at-risk populations in particular, these conditions create both heightened risks and greater opportunities for improved outcomes when strategies are designed with their needs at the center.

This roadmap highlights the strategies with the greatest potential to reduce emissions in the region, while also improving affordability, resilience, and health for Outer Sitka residents. By focusing on high-impact measures that align with local conditions, the community can pursue sustainability actions that achieve both significant emission reductions and meaningful benefits for households most at risk.

### Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Electrification of Heating and Weatherization Upgrades
2. Electrification of Public and Private Transportation
3. Leveraging Hydropower to Expand Electrification

Together, these three strategies account for the vast majority of emission reduction potential in the region. Heating electrification/weatherization directly tackles the largest emissions source. Transportation electrification addresses the second-largest sector. Hydropower-enabled electrification ensures both are powered cleanly and effectively.

## Emissions Data Overview

Note that these data are for the entire Census Area, which contains two Census Tracts.

Total Modeled Emissions: 47,780 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined (total population of 8,063).

### Stationary Combustion (68.27%)

- Residential Sector (50.70%)
  - Residual Fuel Oil No. 5: 22,557.45 mt CO<sub>2</sub>e (~ 47.21% of total)
  - Propane: 833.51 mt CO<sub>2</sub>e (~ 1.74%)
  - Natural Gas: 774.15 mt CO<sub>2</sub>e (~ 1.62%)
  - Wood/Wood Residuals: 60.23 mt CO<sub>2</sub>e (~ 0.13%)
- Commercial Sector (17.57%)
  - Distillate Fuel Oil No. 1: 7,778.05 mt CO<sub>2</sub>e (~ 16.28%)
  - Propane: 593.77 mt CO<sub>2</sub>e (~ 1.24%)
  - Wood/Wood Residuals: 21.59 mt CO<sub>2</sub>e (~ 0.05%)
- Industrial Sector
  - 0% (no industrial stationary emissions in this model)

### Transportation (31.73%)

Fuel types:

- Motor Gasoline: 12,888.56 mt CO<sub>2</sub>e (~ 26.97%)
- Diesel Fuel: 2,273.19 mt CO<sub>2</sub>e (~ 4.76%)

Vehicle types (share of transportation emissions):

- Trucks: 13,231.13 mt CO<sub>2</sub>e (~ 87.27%)
- Passenger vehicles: 1,916.84 mt CO<sub>2</sub>e (~ 12.64%)
- Motorcycles: minimal (13.78 mt CO<sub>2</sub>e, ~ 0.09%)

### Electricity Generation

- Electricity consumption: 120,398.84 MWh
- Generation sources:
  - Hydro: 120,398.84 MWh → 0.00mt CO<sub>2</sub>e

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- The vast majority of emissions (≈ 68%) come from stationary combustion (buildings, heating, etc.), and within that, a large single fuel type—Residual Fuel Oil No. 5—dominates.
- Transportation is a significant source (≈ 32%), especially dominated by gasoline use in trucks (heavy/medium duty) rather than passenger vehicles. Actual transportation-related emissions are likely higher when unmodeled marine and aviation sources are considered.
- Local electricity generation does not contribute to emissions in this inventory; the grid is supplied via non-emitting sources (hydropower).





## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Risk:** Anticipated changes in extreme weather are relatively high (14.77 on the scale provided). This signals increased exposure to environmental hazards.
- **Disaster Loss Risk:** The community ranks at the 43.75th percentile nationally, with an estimated annualized disaster loss of ~\$805,000. This is a moderate risk level, suggesting both vulnerability and potential costs from disasters.
- **Air Pollution and Toxics:** Diesel PM exposure is reported at zero, and toxic air releases are very low (1st percentile nationally). However, air toxics cancer risk is present (9.00), indicating localized risks.
- **Hazardous Facilities:** Outer Sitka has no hazardous sites or Superfund proximity issues, but it is close to a Risk Management Plan (RMP) facility, ranking at the 71st percentile nationally for proximity, meaning higher-than-average exposure risk.
- **Housing Risks:** A notable portion of homes are pre-1980s (43%), ranking in the 64th percentile nationally, suggesting higher risks of legacy issues such as asbestos, lead, or inefficient energy systems.
- **Flood Risk:** 13% of properties face flood risk, ranking at the 73rd percentile nationally, making flooding a significant concern.
- **Other Infrastructure Proximities:** Airport proximity is modest (19.89th percentile), and road exposure is negligible.

**Implications:** Outer Sitka is moderately vulnerable to environmental hazards, particularly flooding and disaster-related damages. While direct air pollution risks are low, legacy housing conditions and proximity to a Risk Management Plan (RMP) facility heighten local exposure concerns. These factors increase the community's sensitivity to environmental stressors and the impacts of extreme weather, which can amplify risks to housing stability, public health, and local infrastructure.

### Public Health Indicators

- **Chronic Disease Prevalence:** Asthma (3.2%), diabetes (2.6%), and hypertension (10.1%) are all below national averages, with percentiles in the mid-20s, suggesting relatively good baseline health.
- **Cancer Prevalence:** At 1.9%, cancer prevalence is also below average (30th percentile).
- **Mental Health:** Poor mental health prevalence (4.2%) is below the national midpoint.
- **Heart Disease & Life Expectancy:** Heart disease ranks at the 33rd percentile, while life expectancy is healthy at 79.2 years, though national low-life expectancy comparisons place the community in the 43rd percentile.

**Implications:** Overall, Outer Sitka residents experience lower-than-average rates of chronic illness, with relatively strong life expectancy. This healthier baseline could strengthen resilience to environmental impacts, though mental health and aging-related vulnerabilities remain important.

### Socioeconomic Factors

- **Poverty and Income:** About 15% live below 200% of the poverty line (23rd percentile nationally), suggesting lower economic hardship compared to many U.S. communities. However, income inequality is moderate (GINI 0.35, 17th percentile).
- **Employment and Education:** Unemployment is low at 3.2%, and only 4.5% lack a high school diploma.
- **Housing:** Nearly one-third of units are renter-occupied (55th percentile), and over a quarter of households face housing cost burdens (57th percentile). Median home value is high (\$382,900), ranking at the 80th percentile nationally. Mobile homes make up 16% of housing (95th percentile nationally), which could signal vulnerability in housing stability.
- **Insurance & Access:** Uninsured rates are relatively high at 14.6% (59th percentile), and internet access gaps affect 7% of households.
- **Demographics:** About 15% of the population is over 65, and 18% under 17. Disability prevalence is notable at nearly 13% (54th percentile).

**Implications:** Socioeconomic conditions are mixed. While education and employment are strong, high housing costs, elevated uninsured rates, and reliance on mobile homes create vulnerabilities. These could amplify sensitivity to environmental and pollution impacts, especially among renters, older adults, and those with disabilities.

### Transportation Insecurity

- **Access:** Transportation access scores are very low (0.92), placing Outer Sitka in the 96th percentile nationally for transportation insecurity. This signals significant mobility challenges.
- **Cost:** Transportation cost burden is low (0.11%), suggesting that while access is limited, the direct financial cost of travel is not the primary barrier.
- **Safety:** Traffic fatalities are low (1.14 per 100,000), placing the community in the 41st percentile.

**Implications:** Transportation access is a major barrier for Outer Sitka residents. Limited mobility could constrain access to healthcare, employment, and essential services, and may create inequities in adapting to or benefiting from emission reduction measures.

### Intersection with Emissions Reduction Planning

Taken together, Outer Sitka's environmental, health, socioeconomic, and transportation conditions highlight both resilience and vulnerability factors:

- **Strengths:** A relatively healthy population, lower poverty rates, and low baseline exposure to air pollution.
- **Vulnerabilities:** Flood risk, aging housing stock (especially mobile homes), limited transportation access, high housing costs, and moderate disaster risk.

These dynamics mean that sustainability strategies will need to consider not just emissions, but also equitable access to benefits (transportation improvements, resilient housing, affordable energy).

Vulnerable groups—renters, low-income households, elders, people with disabilities—will require particular attention to ensure sustainability actions reduce rather than reinforce disparities.

### Mitigation Strategies

#### Transitioning Away from Residual Fuel Oil and Diesel

One of the most significant opportunities for emissions reduction in Outer Sitka lies in reducing reliance on residual fuel oil and diesel, which account for the majority of stationary combustion emissions across the census area. Much of this use occurs in residential and commercial heating, where oil-based systems dominate. Shifting toward high-efficiency electric heat pumps offers a pathway to both emissions reduction and long-term cost savings. At the same time, expanding weatherization and retrofit programs—particularly for pre-1980s homes and mobile homes, which are prevalent in Outer Sitka—would reduce energy demand and improve comfort. For at-risk households, these changes would lessen vulnerability to volatile fuel prices, improve indoor air quality, and provide more stable, healthier living conditions for elders, renters, and residents with chronic health risks.

#### Expanding Resilient, Low-Carbon Transportation

Transportation represents nearly one-third of emissions in the census area, with gasoline consumption in trucks accounting for the bulk of the sector. Outer Sitka also faces severe transportation insecurity, ranking in the 96th percentile nationally. This dual challenge makes transportation a critical focus for emissions reduction and community well-being. Expanding shared mobility options such as shuttle services, demand-responsive transit, and community vans could reduce per capita vehicle reliance while addressing access gaps. In parallel, introducing electric vehicles into public fleets, particularly for school buses and municipal services, would cut gasoline use and demonstrate the feasibility of cleaner transport. Establishing charging infrastructure that serves both households and community facilities would further expand access. For at-risk residents, these changes would reduce barriers to essential services, improve access to work and healthcare, and decrease exposure to traffic-related air pollution.

### **Building Flood and Hazard Mitigation into Housing and Infrastructure**

Outer Sitka's exposure to flooding, with 13 percent of local properties at risk, underscores the importance of resilience investments in housing and infrastructure. Strengthening homes and neighborhoods against flood impacts through strategies such as raised utilities, drainage improvements, and green infrastructure is a necessary component of environmental adaptation. Pairing these measures with energy-efficiency retrofits maximizes the benefits by improving both safety and affordability. This is especially critical for mobile home residents and renters, who often face the highest housing cost burdens and the greatest physical vulnerabilities. For these groups, integrated resilience and efficiency upgrades can help prevent displacement and ensure that housing remains secure and livable under changing environmental conditions.

### **Leveraging Clean, Non-Emitting Electricity**

A distinctive advantage for Sitka is its reliance on hydropower, which results in zero local emissions from electricity generation. This provides a strong foundation for widespread electrification as a sustainability strategy. Encouraging residents and businesses to replace fossil fuel use in heating, cooking, and transportation with electricity would take full advantage of this clean energy supply. To ensure widespread adoption, programs must prioritize affordability and extend direct assistance to households with limited means, including renters and low-income homeowners. For at-risk populations, leveraging clean hydropower not only reduces energy costs but also lessens dependence on imported fossil fuels, insulating households from supply chain disruptions and strengthening long-term resilience.

### **Supporting Community Health and Adaptation**

While Outer Sitka enjoys generally lower rates of chronic disease compared to national averages, challenges related to mental health, aging, and disability are present and must be considered in emissions reduction planning. Emissions reduction strategies can contribute to improved health outcomes by reducing combustion-related indoor air pollutants through electrification and ventilation upgrades. Establishing community hubs that provide reliable heating and cooling in extreme weather also supports vulnerable residents, particularly older adults and those with disabilities. Additionally, linking sustainability investments with local workforce opportunities—such as jobs in retrofitting, energy auditing, and electric transit maintenance—creates direct economic benefits. For at-risk households, these measures not only improve health and safety but also strengthen economic stability and long-term resilience.

### **Improved Outcomes for Overburdened and Underserved Communities**

Improved outcomes for at-risk communities in Outer Sitka mean that sustainability strategies not only reduce emissions but also deliver tangible benefits in health, affordability, and resilience. By replacing oil-based heating systems with efficient electric alternatives, households facing high energy burdens will see lower utility costs and safer, healthier indoor environments. Flood protection and housing retrofits directly safeguard renters and mobile home residents, who are often the most vulnerable to displacement. Expanded access to clean and affordable transportation reduces mobility barriers, enabling better access to healthcare, employment, and education.

At the same time, linking sustainability investments with local job creation ensures that economic benefits flow back into the community. As a result, sustainability action in Outer Sitka becomes not only an emissions reduction strategy but also a means of strengthening the economic stability, health, and resilience of at-risk households. These improved outcomes ensure that the most vulnerable residents are not left behind, but instead see their quality of life enhanced as the region transitions toward a low-carbon future.

**Benefit (Disbenefit) Quantification or Qualitative Analysis****Transitioning Away from Residual Fuel Oil & Diesel (weatherization + heat pumps)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                         | Community Benefits                                                                                                                                                       |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Space heating oil (esp. residual fuel oil) is the single largest source in the census area. If ~30% of oil-heated homes convert to heat pumps, order-of-magnitude 6–8k mt CO <sub>2</sub> e/yr avoided; deeper retrofits + electrification could push higher. | Cuts emissions where at-risk households often live (older/mobile homes); benefits accrue fastest when rebates + no-cost weatherization target low-income renters/owners. |
| Energy cost savings | High             | Typical household heating savings \$1,200–\$1,800/yr after weatherization + heat pump; more in high-fuel-price winters. Community-wide fuel imports fall.                                                                                                     | Reduces energy burden for households already above average burden; stabilizes bills for fixed-income elders; lowers arrearages & shutoff risk.                           |
| Health benefits     | Moderate–High    | Less in-home combustion + ventilation upgrades → improved IAQ; weatherization mitigates moisture/mold.                                                                                                                                                        | Improves outcomes for children, elders, people with respiratory sensitivities; healthier indoor environments in overcrowded or substandard housing.                      |
| Resilience          | Moderate         | Less dependence on delivered fuels; fewer emergency fuel runs; winter reliability improves with envelope upgrades and backup heat planning.                                                                                                                   | Reduces service disruptions that disproportionately impact at-risk households; frees household cash flow for essentials.                                                 |
| Disbenefits / risks | Low–Moderate     | Up-front costs; contractor capacity; winter heat pump performance if envelope is poor; landlord pass-through issues. Mitigations: targeted rebates, contractor training, cold-climate equipment spec, tenant protections, on-bill financing.                  | Ensure eligibility, direct install models, and no-cost options to avoid exclusion.                                                                                       |





### Expanding Resilient, Low-Carbon Transportation (shared mobility + public fleet EVs + charging)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                      | Community Benefits                                                                                                                            |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Transportation ≈ one-third of area emissions (gasoline-dominant). Near-term: fleet electrification + modest mode shift could yield ~2–4k mt CO <sub>2</sub> e/yr reductions; more with sustained adoption.                                 | Prioritize bus/shuttle routes to at-risk neighborhoods and major services; electrify school & municipal fleets that pass through those areas. |
| Energy cost savings | Moderate         | EVs lower operating costs (fuel + maintenance) by \$500–\$1,500/yr per light-duty vehicle; bigger savings for high-mileage public fleets.                                                                                                  | Lower mobility costs where car ownership is a strain; public fleets' savings can stabilize local budgets that fund social services.           |
| Health benefits     | Moderate         | Less tailpipe pollution along busy corridors; quieter vehicles; potential safety gains if paired with traffic calming.                                                                                                                     | Reduces exposure for households near key routes and activity centers; supports access to clinics, schools, jobs.                              |
| Resilience          | Moderate         | More mobility options (demand-responsive, community vans) buffer outages/road closures; diversified fuels reduce price shocks.                                                                                                             | Improves access for residents without cars and for people with disabilities; reduces missed work/appointments.                                |
| Disbenefits / risks | Low–Moderate     | Winter range constraints; charger siting and reliability; risk of uneven access (home charging vs. none). Mitigations: publicly sited Level 2/ fast chargers near at-risk housing & services; reliability O&M plans; cold-weather routing. | Explicitly site chargers and transit upgrades to maximize access; fare policies to keep service affordable.                                   |



**Building Flood & Hazard Mitigation into Housing & Infrastructure (floodproofing + green/gray drainage)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                  | Community Benefits                                                                                                      |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low              | Primarily an adaptation investment; minor indirect reductions from avoided repairs/rebuilds and improved efficiency when combined with retrofits.                                      | N/A directly—pairing with efficiency upgrades enhances benefits.                                                        |
| Energy cost savings | Low–Moderate     | Avoided damage lowers long-run costs; pairing with insulation/equipment elevation reduces losses and downtime.                                                                         | Prevents catastrophic expenses/displacement that hit low-wealth households hardest.                                     |
| Health benefits     | High             | Reduced dampness/mold after floods; safer utilities; fewer displacement-related health shocks.                                                                                         | Protects elders, renters, and mobile-home residents who face greater exposure and fewer recovery resources.             |
| Resilience          | High             | 13% of properties have flood risk—raising equipment, backflow, conveyance upgrades, and green infrastructure materially reduce loss and disruption.                                    | Keeps at-risk households housed; protects critical access routes and community facilities used by vulnerable residents. |
| Disbenefits / risks | Low–Moderate     | Up-front capital; construction disruption; potential insurance or code-compliance costs. Mitigations: grant layering, LMI set-asides, right-sized scopes, schedule around school/work. | Design benefits so renters aren't displaced; include habitability protections during construction.                      |



**Leveraging Clean, Non-Emitting Electricity (hydropower-enabled end-use electrification)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                    | Community Benefits                                                                                            |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High (enabling)  | Local electricity is effectively zero-emitting; electrifying heating & transport shifts large fossil loads (see Strategy #1 & #2 totals) onto clean supply—multiplying reductions over time.             | Ensures at-risk households share in the transition benefits rather than remaining on costlier fossil systems. |
| Energy cost savings | Moderate–High    | Rate-dependent but favorable where hydro is stable; whole-home electrification + efficient appliances shrink total energy spend.                                                                         | Targeted incentives + appliance swaps (ranges, dryers, WHs) reduce monthly bills for low-income households.   |
| Health benefits     | Moderate         | Removing in-home combustion (stoves, space/water heating) improves IAQ; fewer CO risks; quieter homes.                                                                                                   | Benefits children's respiratory health and households in tight/older units with poor ventilation.             |
| Resilience          | Moderate         | Less dependence on delivered fuels; but requires grid readiness (winter peaks). Demand flexibility + weatherization smooth peak loads.                                                                   | Stable local energy improves reliability for residents with medical/ electric needs.                          |
| Disbenefits / risks | Low–Moderate     | Peak demand growth; panel upgrades; potential bill shocks if not paired with efficiency and rate design. Mitigations: envelope-first approach, TOU-aware controls, community programs covering upgrades. | Guard against cost shifts that could disadvantage at-risk customers; use bill protection/on-bill credits.     |





**Supporting Community Health & Adaptation (resilience hubs, ventilation/IAQ, workforce links)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                              | Community Benefits                                                                                               |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low              | Direct reductions are limited; indirect reductions via electrification readiness and behavior change.                                              | N/A directly—co-benefits dominate.                                                                               |
| Energy cost savings | Low–Moderate     | Community facilities can lower operating costs with electrification/efficiency; hubs can coordinate bulk-buy programs that reduce household costs. | Aggregated purchasing and assistance reach at-risk residents who face high transaction barriers.                 |
| Health benefits     | High             | Clean-air shelters, cooling/heating centers, and improved IAQ (filters/ERVs) reduce acute events; continuity of services during outages.           | Disproportionate gains for elders, people with disabilities, young children, and medically vulnerable residents. |
| Resilience          | High             | Hubs provide redundant power, communications, and services; improve disaster response and social cohesion.                                         | At-risk households gain access to safe spaces, charging, refrigeration for meds, and information during events.  |
| Disbenefits / risks | Low              | Capital + O&M needs; staffing. Mitigations: co-locate at libraries/schools, shared staffing, diversified funding, volunteer networks.              | Ensure hours, language access, and transit connections fit needs.                                                |





### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household costs: Reduced heating fuel expenses and lower transportation costs directly ease financial pressure.
- Improved housing conditions: Weatherization and retrofits reduce draft, mold, and dampness, making homes healthier.
- Health gains: Less indoor and outdoor air pollution improves respiratory outcomes; resilience hubs provide safe shelter during extreme events.
- Greater stability: Reduced exposure to fuel price volatility and disaster-related displacement supports long-term household security.
- Better access: Expanded transit and EV infrastructure increase mobility options, improving access to jobs, healthcare, and education.
- Local job creation: Workforce programs in retrofits, electrification, and transit maintenance provide employment opportunities that circulate benefits locally.
- Resilience under environmental stress: Floodproofing, energy reliability, and resilience hubs reduce vulnerability to extreme weather and outages.

Potential disbenefits if not designed equitably:

- Up-front costs: Without subsidies or direct-install programs, initial investments could be unaffordable for low-income households.
- Landlord-tenant split: Renters may not benefit if landlords delay upgrades or pass costs to tenants.
- Infrastructure gaps: EV charging and resilience hubs could be unevenly distributed, leaving some neighborhoods out.
- Grid strain risks: Increased electrification may raise peak demand, potentially impacting affordability if not managed.
- Temporary disruption: Construction, retrofits, or floodproofing projects may inconvenience households or displace renters if not carefully managed.
- Uneven access to programs: Without targeted outreach, at-risk residents may face barriers (language, paperwork, awareness) to participation.

### Path Forward

Outer Sitka and the wider Sitka Census Area have a clear path to meaningful emission reductions by targeting the two largest sources of emissions—residential and commercial heating and gasoline-powered transportation—while leveraging the community’s renewable hydropower resource. Electrification of heating, deep weatherization, and expansion of low-carbon transportation offer the greatest opportunities for immediate and long-term impact. Together, these measures could substantially reduce emissions while lowering household energy costs, improving health outcomes, and strengthening resilience against environmental and economic shocks.

For at-risk households in particular, these strategies represent more than just sustainability actions—they are a chance to lower energy burdens, protect against displacement, and expand access to affordable mobility and healthier living environments. Ensuring that programs are designed with affordability, renter protections, and community engagement at the core will be critical to maximizing benefits and avoiding unintended burdens.

Moving forward, the region can build momentum by prioritizing investments that deliver both emissions reductions and community co-benefits. Early actions should include accelerating residential fuel-switching, expanding shared transit and public fleet electrification, and integrating resilience upgrades into housing improvements. At the same time, building local workforce capacity and aligning state and federal funding sources will be essential for long-term program delivery. By pursuing these strategies in a coordinated and inclusive way, Outer Sitka can demonstrate how emissions reduction and community well-being can advance together, creating a more resilient, affordable, and healthy future.

# Alaska Highway Region, Southeast Fairbanks Census Area

Population: 2,200

Census Tract: 2050000100

Communities: Alcan Border, Chicken, Dot Lake, Dot Lake Village, Dry Creek, Eagle, Eagle Village, Northway, Tanacross, Tetlin, Tok

Tok: By jkbrooks85, wikimedia

The Alaska Highway Region of the Southeast Fairbanks Census Area faces a unique combination of challenges and opportunities as it considers strategies to reduce criteria pollutants and greenhouse gas emissions. With a population of just over 2,200 spread across remote communities, the region is characterized by extreme weather conditions, aging housing stock, high energy and transportation costs, and some of the highest poverty and unemployment rates in the nation. At the same time, residents face significant environmental risks, particularly from flooding, while also experiencing health burdens such as high rates of heart disease, diabetes, and poor mental health outcomes. These conditions create both an urgent need and a clear rationale for aligning sustainability actions with community well-being.

The emissions profile of the region shows that the majority of emissions are generated by heating fuels in homes and businesses, petroleum- and coal-based electricity generation, and gasoline and diesel use in transportation—especially from heavy trucks. Together, these three sources account for nearly all of the region’s emissions, underscoring the importance of focusing strategies where they will make the greatest difference. By prioritizing building energy efficiency and fuel switching, renewable energy expansion, and transportation efficiency, the Alaska Highway Region can achieve meaningful reductions in emissions while at the same time lowering household costs, improving health, and strengthening community resilience. For vulnerable communities in particular, these strategies offer a pathway to more secure, healthier, and more affordable living conditions, ensuring that sustainability action delivers immediate as well as long-term benefits.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Building Energy Efficiency and Fuel Switching
2. Renewable Energy Expansion (Local Solar, Wind, and Storage)
3. Transportation Efficiency and Fleet Shifts

Building energy efficiency/fuel switching, renewable energy expansion, and transportation efficiency stand out as the “big three” strategies for the Alaska Highway Region. Together, they tackle the largest emissions sources while also delivering affordability, resilience, and health benefits—particularly for vulnerable households.

## Emissions Data Overview

Note that these data are for the entire Census Area, which contains two Census Tracts.

Total Modeled Emissions: 113,843 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (51.03%)

- Residential Sector (23.00%)
  - Electricity: 8,264.48 mt CO<sub>2</sub>e (7.26% of total)
  - Natural Gas: 381.30 mt CO<sub>2</sub>e (0.33% of total)
  - Propane: 95.26 mt CO<sub>2</sub>e (0.08% of total)
  - Residual Fuel Oil No. 5: 17,172.17 mt CO<sub>2</sub>e (15.08% of total)
  - Wood & Wood Residuals: 274.77mt CO<sub>2</sub>e (0.24% of total)
- Commercial Sector (28.03%)
  - Distillate Fuel Oil No. 1: 6,053.93 mt CO<sub>2</sub>e (5.32% of total)
  - Propane: 462.15 mt CO<sub>2</sub>e (0.41% of total)
  - Wood & Wood Residuals: 16.80 mt CO<sub>2</sub>e (0.01% of total)
  - Electricity: 25,375.66mt CO<sub>2</sub>e (22.29% of total)
- Industrial Sector: 0%

### Transportation (48.97%)

By fuel type:

- Diesel fuel: 11,391.00 mt CO<sub>2</sub>e (10.01%)
- Motor gasoline: 44,355.28 mt CO<sub>2</sub>e (38.96%)
- Electricity (for electric vehicles, etc.): 0.41 mt CO<sub>2</sub>e (negligible)

By vehicle type (within transport):

- Trucks: 49,807.65 mt CO<sub>2</sub>e (89.35 % of transport emissions)
- Passenger vehicles: 5,834.71mt CO<sub>2</sub>e (10.47%)
- Motorcycles: 104.33 mt CO<sub>2</sub>e (0.19%)

### Electricity Generation

- Electricity consumption: 124,236.17 MWh
- Generation sources:
  - Petroleum: 94,419.49 MWh → 27,192.81 mt CO<sub>2</sub>e → 80.83% of electricity-generation emissions
  - Coal: 16,150.70 MWh → 5,173.07 mt CO<sub>2</sub>e → 15.38%
  - Natural Gas: 6,211.81 MWh → 1,274.66 mt CO<sub>2</sub>e → 3.79%
  - Wind: 3,727.09 MWh → 0 mt CO<sub>2</sub>e (zero emissions)
  - Hydro: 2,484.72 MWh → 0 mt CO<sub>2</sub>e
  - Solar: 1,242.36 MWh → 0 mt CO<sub>2</sub>e

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- The region's emissions are dominated by stationary combustion (51 %) and transportation (49 %), with electricity generation accounting for another significant slice (23 %)—note overlap when attributing Scope 1 and Scope 2.
- Within stationary combustion, fuel oil (Residual Fuel No. 5) is a large emitter.
- In transportation, gasoline usage and truck-related emissions are dominant.
- Electricity generation is powered mostly via petroleum and coal, with a small portion from natural gas and a modest share of renewables (wind, hydro, solar) producing zero direct emissions.

## Social Determinants of Health

### Environmental Factors

- **Extreme Weather Risk:** Anticipated changes in extreme weather are moderate (12.5 percentile nationally), but 42% of properties face flood risk, ranking in the 94th percentile nationally.
- **Pollution Exposure:** Diesel particulate matter (PM) exposure is reported at 0, with low rankings for toxic releases (2nd percentile), hazardous waste, and Superfund proximity.
- **Air Toxics & Cancer Risk:** Air toxics cancer risk is at the 8th percentile, relatively low but not negligible.
- **Built Environment Risks:** Pre-1980s housing (37%) and proximity to airports (2.15%) add localized risks, while proximity to high-volume roads is minimal.
- **Military Legacy:** The presence of formerly used defense sites may pose potential contamination concerns.

Implication: Environmental vulnerabilities are less about air quality and more concentrated on environment flooding risk, legacy military sites, and aging housing stock. This highlights a need to integrate resilience planning into any future pollution reduction roadmap

### Public Health Indicators

- **Chronic Disease Prevalence:** Asthma (4.6%) and diabetes (5.1%) are moderate, but heart disease is very high (83rd percentile nationally).
- **Mental Health:** Poor mental health prevalence (6.6%) is around the national midpoint but combined with other risks may create compounding challenges.
- **Life Expectancy:** Average life expectancy (76.7 years) is lower than the national average, ranking in the 67th percentile for low life expectancy.

Implication: The high heart disease burden and lower life expectancy suggest that health vulnerabilities are significant and may be worsened by environmental stressors. Any pollution reduction measures must be paired with strategies that safeguard cardiovascular and mental health resilience.

### Socioeconomic Factors

- **Poverty & Education:** A striking 70.6% of the population lives below 200% of the federal poverty line, and nearly one-quarter (23.7%) have no high school diploma—both at the 100th percentile nationally.
- **Employment & Income:** Unemployment (13%) is very high (97th percentile), and income inequality is also high (GINI 0.43, 75th percentile).
- **Housing & Cost Burden:** While housing cost burden is relatively low (15.5%), median home values are low (\$142,600), reflecting limited local wealth.
- **Access & Coverage:** Nearly 16% are uninsured (66th percentile), 38.5% lack internet (96th percentile), and energy burden is very high (93rd percentile).
- **Demographics:** Youth population is disproportionately high (39%, 98th percentile), while seniors make up only 7.9%. Disability prevalence is also elevated (13.4%).

Implication: The region faces deep socioeconomic disadvantage, high unemployment, and energy/internet access challenges, all of which amplify vulnerability to environmental impacts and limit adaptive capacity. The large youth population may be both a vulnerability and a resource for future workforce and emissions reduction planning.

### Transportation Insecurity

- **Access & Costs:** Transportation access is very limited (0.01 score), and households experience one of the highest transportation cost burdens nationally (97th percentile).
- **Safety:** Traffic fatality rates are moderate at 2 per 100,000.

Implication: With extremely high transportation costs and very low access, residents are highly dependent on limited and expensive transport options. This creates barriers to healthcare, education, and employment while also increasing vulnerability to environment-related disruptions.



## Intersection with Emissions Reduction Planning

The intersection of these social determinants with emissions reduction planning reveals several critical points:

- Flooding vulnerability will magnify housing insecurity and property loss unless resilience is prioritized in sustainability action.
- High poverty and unemployment limit households' ability to absorb costs associated with transitions to cleaner energy or transportation.
- Youth-heavy demographics suggest a need to frame strategies around intergenerational opportunity and skills-building.
- Energy and transportation burdens are already disproportionately high, meaning that pollution reduction strategies must carefully avoid raising costs further.
- Health vulnerabilities—especially heart disease—indicate that pollution reduction should be pursued alongside health protection to prevent exacerbating chronic conditions.

## Mitigation Strategies

### Building Energy Efficiency and Fuel Switching

In the Alaska Highway Region, stationary combustion from residential and commercial heating is one of the most significant contributors to emissions. The reliance on fuel oil, combined with an older housing stock and some of the nation's highest rates of poverty, leaves households struggling with extreme energy costs. Weatherization programs—focused on insulation, windows, and building shell improvements—would help reduce the demand for heating fuels while improving comfort in subarctic conditions. Introducing cold-climate heat pumps in tandem with efficiency upgrades would enable households to reduce reliance on oil, provided that power supply shifts toward cleaner sources. For families in this region, these upgrades mean not only a pathway to substantial emissions reductions but also direct relief from high energy burdens, more stable home environments, and improved respiratory and cardiovascular health through reduced indoor air pollution.

### Renewable Energy Expansion

Electricity in the Alaska Highway Region is heavily dependent on petroleum and coal, even as small-scale wind, hydro, and solar are already present in the system. Expanding local renewable generation—especially solar paired with storage and community-scale wind—presents one of the most transformative opportunities for this region. Doing so would help reduce dependence on costly imported fuels, stabilize rates in the face of volatile global energy markets, and expand local control over energy resources. Given the remote character of the Alaska Highway Region, microgrids powered by renewables and supported by storage could also provide resilience during disruptions. For low-income households, community solar or shared renewable models could offer affordable entry points, ensuring that benefits flow equitably across the region.

### Transportation Efficiency and Alternatives

Transportation emissions in Southeast Fairbanks are nearly as large as those from buildings, dominated by trucks and gasoline consumption. For the Alaska Highway Region, where distances are long, access to alternatives is minimal, and transportation costs rank among the highest nationally, mobility is a defining challenge. Incremental improvements could begin with expanding electric vehicle infrastructure for light-duty use in community hubs, coupled with financial support that enables low-income residents to participate in the shift. Heavy-duty vehicles, central to freight and community supply chains, will take longer to transition, but idle-reduction programs and more efficient fleet management could yield near-term reductions. At the same time, providing modest shared transport options, such as shuttles or rideshare services, would reduce isolation, particularly for households without reliable vehicles. In a region where residents are deeply tied to long-haul transportation networks, these measures are not only about cutting emissions—they are also about reducing economic strain and ensuring mobility for all.

### **Flood and Hazard Mitigation in Housing**

The Alaska Highway Region faces serious flood risks, with nearly half of properties at some level of exposure. This risk compounds existing vulnerabilities created by low household incomes, limited insurance coverage, and older housing stock. Flood resilience strategies—such as elevating structures, improving drainage, and retrofitting homes with durable, weather-resistant materials—will be critical to safeguarding both residents and community infrastructure. When paired with energy efficiency measures, these upgrades deliver double benefits: reducing fuel use while protecting homes from environment-related damage. For residents who cannot easily rebuild after disaster, integrating resilience into housing programs ensures stability, prevents displacement, and sustains the affordability of local housing.

### **Community Health and Co-Benefits**

The Alaska Highway Region struggles with significant health challenges, including high rates of heart disease, diabetes, and poor mental health outcomes, as well as lower-than-average life expectancy. Pollution reduction strategies here can deliver health co-benefits alongside emissions cuts. For example, reducing reliance on fuel oil and diesel improves indoor air quality, lowering exposure to pollutants that exacerbate chronic disease. Investments in safe and accessible active transport infrastructure, such as trails and sidewalks, would not only reduce emissions modestly but also support healthier lifestyles. Moreover, coupling energy cost savings with supports for healthcare and nutrition could amplify the health benefits, helping households manage the intersecting challenges of poverty, illness, and energy stress.

### **Workforce Development and Local Capacity**

A defining feature of the Alaska Highway Region is its young population and persistently high unemployment rate. These conditions present both a challenge and an opportunity. By tying mitigation strategies to local workforce training, the region can create durable economic pathways while scaling up the capacity needed to deliver energy and transportation projects. Training residents in skills such as renewable energy installation, weatherization, and vehicle efficiency retrofits not only reduces reliance on outside contractors but also ensures that economic benefits remain in the community. For young people in particular, these pathways create a sense of future stability and purpose while reinforcing local ownership of environmental solutions. Over time, investing in workforce development in the Alaska Highway Region ensures that sustainability planning is not simply imported from outside but is built and sustained from within.

### **Improved Outcomes for Overburdened and Underserved Communities**

For communities in the Alaska Highway Region, emissions reduction strategies present an opportunity to address long-standing inequities in energy burden, health outcomes, and economic resilience. Residents currently face some of the nation's highest rates of poverty, unemployment, and transportation costs, alongside disproportionate risks from flooding and aging housing. By targeting energy efficiency and renewable energy investments toward these households, strategies can directly reduce monthly utility and fuel expenses, making basic living costs more manageable. Cleaner heating systems and reduced reliance on fuel oil also lower indoor pollutants, improving respiratory and cardiovascular health in communities already burdened with high rates of heart disease and diabetes.

At the same time, outcomes can be strengthened through workforce training and local hiring for weatherization, renewable energy projects, and transportation upgrades. These efforts would provide much-needed job opportunities for a community with a very young population and limited employment pathways. Improved mobility through affordable transport options reduces isolation and increases access to healthcare, education, and economic participation. Together, these measures ensure that pollution reduction strategies do more than lower emissions—they create healthier homes, stronger local economies, and more resilient communities that are better prepared for the challenges of a changing environment.

**Benefit (Disbenefit) Quantification or Qualitative Analysis****Building Energy Efficiency & Fuel Switching (weatherization)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                      | Community Benefits                                                                                                                     |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Buildings are the largest stationary source. If ~20–35% of heating fuel use is reduced via envelope + weatherization, that's on the order of ~11,000–20,000 mtCO <sub>2</sub> e/yr (back-of-envelope from building share). | Directly lowers fuel use in high-burden households; benefits accrue first where need is greatest.                                      |
| Energy cost savings | High             | Typical 20–40% household energy savings.                                                                                                                                                                                   | Reduces energy burden where poverty and unemployment are high; frees disposable income for essentials.                                 |
| Health benefits     | Moderate–High    | Lower indoor PM and combustion byproducts; improved thermal comfort; fewer cold-stress days.                                                                                                                               | At-risk households often endure older housing and indoor air issues; measurable gains in comfort and respiratory/cardiovascular risks. |
| Resilience          | Moderate         | Tighter envelopes keep homes habitable longer in outages; less frequent fuel deliveries needed.                                                                                                                            | Reduces disruption risk in remote areas and during storms; prioritization prevents worst hardship.                                     |
| Disbenefits / risks | Low–Moderate     | Up-front costs; contractor shortages; potential bill increases if electricity is expensive without envelope fixes.                                                                                                         | If not subsidized, communities may be excluded; program design must cover full costs and offer inclusive delivery.                     |



Eagle: By Jet Lowe - Library of Congress, wikimedia

**Renewable Energy Expansion (distributed solar/wind + storage; microgrids)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                              | Community Benefits                                                                                                                   |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Displacing petroleum/coal-based electricity by ~30–60% of power emissions could yield ~8,000–16,000 mtCO <sub>2</sub> e/yr.        | Cleaner local power lowers system-wide emissions and exposure, creating room for clean heating/EVs that can be adopted with support. |
| Energy cost savings | Moderate         | Savings depend on avoided diesel/oil and financing; storage raises capex but can stabilize rates and reduce volatility.            | Rate stability helps households with thin margins; community solar models can share benefits with renters/low-income.                |
| Health benefits     | Moderate         | Fewer local combustion hours; marginal improvement in ambient air quality and noise near generators.                               | Benefits accrue to communities adjacent to gensets and fuel storage.                                                                 |
| Resilience          | High             | Local generation + storage enhances outage ride-through and reduces dependence on deliveries.                                      | Especially valuable in remote at-risk communities with costly/uncertain fuel logistics.                                              |
| Disbenefits / risks | Moderate         | High capex; intermittency without adequate storage; O&M capacity; tariff design must avoid shifting costs to low-income customers. | Poorly structured cost recovery can burden residents—guard with bill protections and inclusive ownership models.                     |

**Transportation Efficiency & Alternatives (EVs, charging, fleet retrofits, shared options)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                     | Community Benefits                                                                                                                        |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Light-duty EV conversions and anti-idling/efficiency retrofits for heavy trucks could trim ~5–15% of transport emissions near-term (thousands of mtCO <sub>2</sub> e/yr). | Siting chargers in community hubs and supporting used-EV access makes benefits reachable for everyone; cleaner corridors reduce exposure. |
| Energy cost savings | Moderate         | EVs lower \$/mi where charging is available; heavy-duty savings depend on duty cycle and fuel prices; shared shuttles cut household spend.                                | Low-cost mobility expands access to jobs/healthcare; but only if charging + financing support are available.                              |
| Health benefits     | Moderate         | Reduced tailpipe pollutants, especially in settlements along freight routes and schools.                                                                                  | At-risk residents often live nearer traffic; localized exposure reductions are meaningful.                                                |
| Resilience          | Low–Moderate     | Redundancy if charging networks and depot power are resilient; winter reliability requires planning.                                                                      | Reliable, affordable mobility reduces isolation for at-risk households.                                                                   |
| Disbenefits / risks | Moderate         | Cold-weather range loss; upfront vehicle costs; slow heavy-duty turnover; uneven charging access; utility demand charges.                                                 | Risk of widening gaps if infrastructure clusters in higher-income areas—targeted siting and incentives are essential.                     |



**Flood & Hazard Mitigation in Housing (elevations, drainage, integrated retrofits)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                       | Community Benefits                                                                                                                       |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low              | Primarily an adaptation play; modest indirect reductions if integrated with energy upgrades.                | Minimal emissions impact but strong protective effect for vulnerable households.                                                         |
| Energy cost savings | Low–Moderate     | Savings arise when resilience retrofits are bundled with weatherization (e.g., envelope/drainage upgrades). | Keeps energy bills predictable post-disaster; helps avoid displacement and rebuild debt.                                                 |
| Health benefits     | Moderate–High    | Reduced mold/moisture, fewer displacement events, mental-health stability after floods.                     | At-risk residents face the steepest recovery barriers; stabilizes housing and health.                                                    |
| Resilience          | High             | Directly reduces loss/damage in an area with very high flood risk; protects community assets.               | Prioritizing at-risk homes prevents cascading social/economic impacts.                                                                   |
| Disbenefits / risks | Moderate         | High per-home costs; construction access/logistics; potential premium increases; managed retreat tradeoffs. | If cost-share is required, communities may be left out; program design must cover full costs and provide relocation support when needed. |

**Community Health & Co-Benefits (active transport, IAQ, paired social supports)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                 | Community Benefits                                                              |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate     | Indirect: mode shift + cleaner indoor environments amplify savings from other measures.                                                               | Helps residents participate in and benefit from broader decarbonization.        |
| Energy cost savings | Low              | Minor direct savings; realized via reduced vehicle miles and more efficient homes.                                                                    | Small but meaningful cumulative relief for tight budgets.                       |
| Health benefits     | High             | IAQ improvements + physical activity lower respiratory/cardiovascular risks where rates are elevated; mental-health gains from reduced energy stress. | Targets conditions disproportionately affecting at-risk communities.            |
| Resilience          | Moderate         | Stronger social services and safer walking/biking improve access during disruptions.                                                                  | Builds everyday and crisis-time access for households with limited transport.   |
| Disbenefits / risks | Low              | Requires coordination across sectors; benefits can be diffuse without targeting.                                                                      | Targeted delivery (schools, clinics, housing) ensures capturing benefits first. |

**Workforce Development & Local Capacity (training, local hire, contractor ecosystem)**

| Outcome             | Potential Impact        | Quantitative / Qualitative Assessment                                                             | Community Benefits                                                                   |
|---------------------|-------------------------|---------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| GHG reduction       | Low–Moderate (indirect) | Enables scale and speed of all other strategies; determines whether reductions persist.           | Creates on-ramps for youth and unemployed at-risk residents to participate and earn. |
| Energy cost savings | Low–Moderate (indirect) | More local crews lower project backlog/cost; speeds household upgrades.                           | Reduces wait times and improves access to upgrades for at-risk homes/facilities.     |
| Health benefits     | Low–Moderate (indirect) | Faster execution of IAQ/efficiency projects; income stability improves determinants of health.    | Income + skills gains improve long-term well-being.                                  |
| Resilience          | High                    | Local capacity keeps systems running during outages and supply disruptions.                       | Empowers communities to maintain microgrids and buildings without outside crews.     |
| Disbenefits / risks | Low–Moderate            | Training attrition; limited local employers; need for wraparound supports (childcare, transport). | Without stipends/supports, participation can lag—design programs to remove barriers. |

**Cross-Cutting Community Benefits and Disbenefits**

Across all strategies, benefits for community benefits include:

- Lower household costs: Weatherization, fuel switching, and renewables reduce extreme energy and transportation burdens.
- Improved health outcomes: Cleaner indoor air, reduced exposure to diesel exhaust, and more stable housing lessen risks of heart disease, asthma, and stress.
- Housing stability: Flood resilience and efficiency retrofits protect low-income families from displacement and costly repairs.
- Job creation: Training and local hiring for efficiency, renewables, and fleet upgrades provide stable employment opportunities for youth and unemployed residents.
- Community resilience: Microgrids, storage, and housing upgrades reduce vulnerability to outages, fuel supply disruptions, and disasters.
- Mobility access: Shared transportation and EV infrastructure open up affordable, reliable access to healthcare, education, and jobs.

Potential disbenefits if not designed equitably:

- High upfront costs: Without subsidies, low-income households may be excluded from upgrades.
- Equity gaps in deployment: EV chargers, renewables, or resilience investments may cluster in higher-income areas if not carefully targeted.
- Energy cost shifts: Poorly structured utility or financing models could shift costs onto vulnerable households.
- Program access barriers: Training or retrofit programs may exclude some without wraparound supports (childcare, transport, flexible financing).
- Reliability concerns: Cold-climate performance issues with EVs could undermine trust if not designed for Alaska's conditions.

## Path Forward

The Alaska Highway Region stands at an important crossroads. Its emissions profile reveals a heavy reliance on fuel oil for heating, petroleum and coal for electricity, and long-haul trucking for transportation—together forming the backbone of its criteria pollutants and greenhouse gas emissions. At the same time, the region faces high poverty rates, elevated energy and transportation burdens, and health outcomes that are already compromised by chronic disease and environmental stressors. These realities make it clear that emissions reduction cannot be pursued in isolation, but must instead be integrated with strategies that strengthen community resilience and improve daily life.

The most impactful strategies—improving building efficiency and transitioning to cleaner heating systems, expanding renewable energy resources, and addressing transportation costs and emissions—offer not only meaningful emission reductions but also immediate benefits for households and communities. They have the potential to lower energy bills, reduce dependence on volatile fuel markets, create local job opportunities, and improve health outcomes. When designed with a focus on vulnerable households, these strategies can help close long-standing gaps in affordability, access, and resilience.

Moving forward, the path for the Alaska Highway Region will require building local capacity to implement and maintain solutions, ensuring equitable access to programs, and securing resources that reduce up-front costs for households and businesses. It will also mean aligning mitigation efforts with adaptation needs, particularly in addressing flood risks and protecting vulnerable housing. By focusing on these priorities, the region can achieve measurable emissions reductions while also creating stronger, healthier, and more resilient communities prepared for the challenges of a changing environment.



# Delta Region, Southeast Fairbanks Census Area

Population: 4,878

Census Tract: 2240000400

Communities: Big Delta, Delta Junction, Deltana, Fort Greely, Healy Lake, Whitestone

The Delta region, located within the Southeast Fairbanks Census Area, faces a unique set of challenges and opportunities as it considers pathways to reduce criteria pollutants and greenhouse gas (GHG) emissions. With a population of under 5,000 residents, Delta is a small but vital hub in interior Alaska, shaped by its rural context, extreme environmental conditions, and reliance on imported fossil fuels. The region's emissions profile reflects these realities: heating oil and diesel are the primary fuels for homes and businesses, petroleum and coal supply most local electricity, and trucking dominates transportation activity. Together, these sources drive an estimated 114,000 metric tons of CO<sub>2</sub>e annually across the census area, with Delta contributing a significant share.

At the same time, Delta's social and economic conditions reveal high energy burdens, limited access to healthcare and insurance, gaps in digital connectivity, and a substantial proportion of properties at risk from flooding. These factors underscore the need for mitigation strategies that not only cut emissions but also address community well-being and resilience. For at-risk residents, the benefits of cleaner energy, more efficient housing, and resilient infrastructure extend well beyond emissions reductions—they mean lower household costs, improved health, and greater security in the face of disasters. By tailoring solutions to its specific conditions, the Delta region can pursue a sustainable energy roadmap that advances GHG reduction while improving the everyday lives of its residents.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Building Energy Efficiency & Fuel Switching
2. Renewable Energy Expansion & Grid Decarbonization
3. Transportation Efficiency & Fleet Electrification

Taken together, these three strategies address the biggest emission sources (heating fuels, electricity generation, and trucking) while also directly improving household affordability, health, and resilience for at-risk populations.



## Emissions Data Overview

Note that these data are for the entire Census Area, which contains two Census Tracts.

Total Modeled Emissions: 113,843 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (51.03%)

- Residential Sector (23.00%)
  - Electricity: 8,264.48 mt CO<sub>2</sub>e (7.26% of total)
  - Natural Gas: 381.30 mt CO<sub>2</sub>e (0.33% of total)
  - Propane: 95.26 mt CO<sub>2</sub>e (0.08% of total)
  - Residual Fuel Oil No. 5: 17,172.17 mt CO<sub>2</sub>e (15.08% of total)
  - Wood & Wood Residuals: 274.77mt CO<sub>2</sub>e (0.24% of total)
- Commercial Sector (28.03%)
  - Distillate Fuel Oil No. 1: 6,053.93 mt CO<sub>2</sub>e (5.32% of total)
  - Propane: 462.15 mt CO<sub>2</sub>e (0.41% of total)
  - Wood & Wood Residuals: 16.80 mt CO<sub>2</sub>e (0.01% of total)
  - Electricity: 25,375.66mt CO<sub>2</sub>e (22.29% of total)
- Industrial Sector: 0%

### Transportation (48.97%)

By fuel type:

- Diesel fuel: 11,391.00 mt CO<sub>2</sub>e (10.01%)
- Motor gasoline: 44,355.28 mt CO<sub>2</sub>e (38.96%)
- Electricity (for electric vehicles, etc.): 0.41 mt CO<sub>2</sub>e (negligible)

By vehicle type (within transport):

- Trucks: 49,807.65 mt CO<sub>2</sub>e (89.35 % of transport emissions)
- Passenger vehicles: 5,834.71mt CO<sub>2</sub>e (10.47%)
- Motorcycles: 104.33 mt CO<sub>2</sub>e (0.19%)

### Electricity Generation

- Electricity consumption: 124,236.17 MWh
- Generation sources:
  - Petroleum: 94,419.49 MWh → 27,192.81 mt CO<sub>2</sub>e → 80.83% of electricity-generation emissions
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  - Natural Gas: 6,211.81 MWh → 1,274.66 mt CO<sub>2</sub>e → 3.79%
  - Wind: 3,727.09 MWh → 0 mt CO<sub>2</sub>e (zero emissions)
  - Hydro: 2,484.72 MWh → 0 mt CO<sub>2</sub>e
  - Solar: 1,242.36 MWh → 0 mt CO<sub>2</sub>e

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use)

- Not included in this dataset.

### Key Takeaways

- The emissions profile is nearly evenly split between the built-environment (stationary) combustion and transportation sectors, with electricity generation also contributing substantially.
- Heating and industrial heating fuels (oil, distillate) are dominant in stationary emissions.
- The transportation sector is heavily weighted toward truck fuel (gasoline, diesel) rather than passenger vehicles or EVs.
- Electricity generation relies heavily on petroleum and coal, with minimal natural gas and small contributions from renewables.

## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather:** Anticipated changes in extreme weather are high (48.86), with annualized disaster loss ranking in the 95th percentile nationally, representing nearly \$4 million in losses annually.
- **Pollution Exposure:** Diesel particulate matter exposure is negligible (0.00), but air toxics cancer risk (8.00) is measurable.
- **Hazardous Sites:** Proximity to hazardous waste, toxic releases, and superfund sites is relatively low (10–13th percentiles nationally). However, the area does contain Formerly Used Defense Sites, which may carry legacy contamination concerns.
- **Housing & Infrastructure Risk:** Nearly one-third of properties (30%) face flood risk, ranking in the 91st national percentile. Housing stock includes a modest percentage of pre-1980s homes (31.21%) and pre-1960s homes (8%).
- **Transportation/Industrial Proximity:** Low proximity to airports and highways, reducing exposure to associated pollutants.

Implications: Environmental risks are uneven—while industrial pollution exposure is relatively low, flood risk and environmental disasters are very high. This suggests that resilience planning will be central to public health and infrastructure sustainability.

### Public Health Indicators

- **Chronic Conditions**
  - Asthma prevalence (3.45%) and diabetes (3.50%) are modest, both below national averages but not negligible.
  - Cancer prevalence is 2.25%, with blood pressure at 14.75%, reflecting mid-range risk levels.
  - Poor mental health prevalence is 4.85%, suggesting meaningful but not extreme mental health burdens.
- **Mortality & Life Expectancy**
  - Reported average life expectancy is 0.00 (likely unmeasured or suppressed due to small population size).
  - National percentile scores place heart disease and cancer prevalence near the 40th percentile, not especially high but relevant in small, isolated populations.

Implications: The health profile shows moderate chronic disease prevalence, but mental health concerns are notable. In an isolated Arctic environment, even moderate health burdens are magnified by limited access to medical infrastructure. This creates a fragile baseline for community resilience in the face of environmental and environmental stressors.

### Socioeconomic Factors

- **Poverty & Education:** Roughly 24% of the population lives under 200% of the federal poverty line, with 6.5% lacking a high school diploma. Both are near national midpoints.
- **Employment:** Unemployment is high (6.2%), placing the area in the 73rd percentile nationally.
- **Insurance & Health Access:** 17.1% of residents are uninsured, among the highest quartile nationally.
- **Digital & Energy Burden:** Lack of internet access is strikingly high at 29.3% (89th percentile), while energy burden is 4% of annual costs (77th percentile), reflecting high heating/fuel costs typical in Alaska.
- **Demographics:** A large share of the population is youth (28.7%, 81st percentile), with 12.6% age 65+. Disability prevalence is high (15.9%, 76th percentile).
- **Housing:** Housing is relatively affordable (median value \$196,900), but mobile homes are common (7.6%, 80th percentile nationally), and older housing stock may lack energy efficiency.

Implications: Economic vulnerability, high uninsured rates, digital inequities, and energy cost burdens present major barriers to resilience. These factors amplify exposure to environmental risks and reduce the community's capacity to adapt.

### Transportation Insecurity

- **Access & Costs:** The transportation access score is low (0.46, 79th percentile of insecurity), indicating difficulty accessing reliable transit. Transportation costs are moderate (13% of household spending).
- **Safety:** Traffic fatalities are modest (1.29 per 100,000), near national averages.

**Implications:** Limited transportation access can isolate vulnerable populations during extreme weather events and hinder employment or healthcare access. This represents a major challenge for community safety, continuity of services, and overall regional stability in a rural area.

### Intersection with Emissions Reduction Planning

- **Flood and Disaster Vulnerability:** Given high flood risk and disaster loss potential, any sustainability strategies must be framed as resilience investments that protect lives, property, and community health.
- **Economic and Energy Burdens:** High energy costs and prevalence of older/mobile housing suggest strong community interest in energy efficiency and cost-saving clean energy solutions, though financial constraints will be a barrier.
- **Healthcare & Insurance Gaps:** A high uninsured population means that environment-related health impacts (e.g., respiratory illness from wildfires, injury from disasters) may go untreated, increasing vulnerability.
- **Digital Divide:** Lack of internet access will impede communication of warnings, information on energy programs, and remote participation in sustainability planning.
- **Youth and Disability Populations:** With high proportions of youth and disabled residents, strategies must consider equity in accessibility, safety, and long-term sustainability.

## Mitigation Strategies

### Building Energy Efficiency and Fuel Switching

The data show that residential and commercial stationary fuel use accounts for over half of local emissions, driven largely by residual fuel oil and distillate heating fuels. This aligns with the social determinants profile: many households face a high energy burden (77th percentile nationally), and housing stock includes a notable share of mobile homes and older, less efficient structures. Strategies focused on weatherization, insulation, and appliance retrofits would significantly reduce fuel use while lowering household energy costs. Supporting households in switching from fuel oil to biomass district heating systems could produce durable reductions in emissions while also reducing financial strain on families already contending with high poverty and uninsured rates. For at-risk households, these interventions translate directly into improved affordability, healthier indoor environments, and reduced vulnerability to extreme cold.

### Renewable Energy Expansion and Grid Decarbonization

Electricity generation in the census area remains heavily dependent on petroleum and coal, which together account for over 95% of power sector emissions. While small contributions from hydro, wind, and solar exist, scaling up these resources is a clear pathway for mitigation. Localized microgrids and community solar projects could reduce reliance on imported fuels, buffer against high energy prices, and improve resilience during extreme weather events. For at-risk residents, who face high rates of disability, digital exclusion, and limited financial flexibility, more affordable and stable energy sources mean improved household stability and reduced exposure to disruptions. Shifting toward renewables would not only cut emissions but also enhance community-level resilience to both energy insecurity and disaster recovery challenges.

### Transportation Efficiency and Electrification

The transportation sector contributes nearly half of total emissions, dominated by gasoline and diesel use in trucks. This reflects the region's rural character, long travel distances, and high dependence on freight and trucking for goods movement. Expanding the availability of efficient vehicle technologies, encouraging fleet turnover for local businesses, and investing in charging or alternative-fuel infrastructure could gradually reduce this burden. Public subsidies or cooperative models may be needed given the region's high unemployment (73rd percentile nationally) and transportation access challenges (79th percentile of insecurity). Even modest investments in EV-ready infrastructure, support for efficient trucks, or incentives for ridesharing could improve outcomes for at-risk residents by reducing transportation costs and ensuring continued mobility during fuel price volatility.

### Flood and Hazard Mitigation Infrastructure

Environmental data show that 30% of local properties in the Delta region face flood risk, placing the area among the highest percentiles nationally. The region also experiences significant disaster-related losses and contains former defense sites that could complicate cleanup and recovery after major storms. Implementing green infrastructure, home elevation or relocation programs, and improved drainage systems would directly reduce these hazards. These investments would result in safer housing, fewer costly repairs, and less displacement for residents with limited financial resources or those living in mobile and older homes.

### Communications and Digital Access

While not an emissions driver, the lack of internet access among nearly 30% of residents significantly constrains the region's ability to adopt and benefit from mitigation strategies. Access to digital platforms is critical for receiving weather warnings, applying for assistance programs, and participating in planning processes. Integrating digital access improvements alongside sustainability programs would ensure that at-risk households benefit from efficiency upgrades, transportation subsidies, and renewable energy offerings. This step supports both emissions reduction and public safety by improving the reach of sustainability-related information and services.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes for at-risk populations in the Delta Region of the Southeast Fairbanks Census Area hinge on aligning emissions reduction strategies with the everyday challenges these households face. By targeting interventions where emissions overlap with financial and health burdens—such as high heating oil dependence, transportation costs, and flood risk—mitigation becomes a vehicle for improving quality of life. For example, weatherization and fuel-switching programs would not only reduce emissions but also lower household energy costs, making heating more affordable for low-income families and seniors. Expanded renewable energy generation would stabilize utility prices in a region vulnerable to fuel price volatility, providing greater financial security for households with limited disposable income. Similarly, investments in transportation efficiency and electrification could reduce the disproportionate burden of travel costs in rural communities while ensuring access to jobs, schools, and healthcare.

For vulnerable populations, the outcomes of these strategies extend beyond economics. Reduced indoor air pollution from cleaner heating sources supports better respiratory health, a critical gain for those without insurance or reliable healthcare access. Improved flood resilience directly translates into safer housing for mobile home residents and others living in vulnerable areas, reducing displacement and recovery costs after disasters. Increasing digital access alongside sustainability investments ensures that residents are better connected to emergency alerts, assistance programs, and community planning. Collectively, these measures would help at-risk households achieve greater stability, safety, and long-term well-being, while at the same time strengthening the region's overall capacity to adapt to and mitigate environmental impacts.



**Benefit (Disbenefit) Quantification or Qualitative Analysis****Building Energy Efficiency & Fuel Switching**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                              | Community Benefits                                                                                                                             |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Targeting weatherization + oil/ other fuel switching across a meaningful share of homes and small commercial could abate ~20–40% of stationary emissions ≈ 11,600–23,200 mtCO <sub>2</sub> e/yr (from ~58,094 mt). | Prioritizing high-burden households lowers emissions where energy use is most intense and least efficient; improves affordability and comfort. |
| Energy cost savings | High             | Typical whole-home efficiency + fuel switching can reduce space heating bills ~15–35% per participating home; aggregate savings scale with uptake and winter severity.                                             | Disproportionate relief for households with high energy burden, seniors in fixed-income housing, and residents of older/ mobile homes.         |
| Health benefits     | High             | Reduced indoor combustion, better ventilation, tighter envelopes → fewer drafts/mold triggers; improved thermal safety in cold spells.                                                                             | Benefits accrue to uninsured/ underinsured and medically vulnerable residents; improved IAQ supports better respiratory outcomes.              |
| Resilience          | Moderate–High    | Weatherized buildings hold heat longer during outages; backup/thermal storage enhance survivability in cold snaps.                                                                                                 | Reduces displacement risk and emergency heating costs for at-risk households during extreme events.                                            |
| Disbenefits/ risks  | Moderate         | Upfront costs; contractor capacity; split incentives for renters.                                                                                                                                                  | Without no-cost/low-cost programs, some residents may be left out; tenant protections needed so upgrades don't translate to rent hikes.        |



## Renewable Energy Expansion &amp; Grid Decarbonization

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                        | Community Benefits                                                                                                             |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Displacing fossil generation with renewables/storage and efficiency in end-uses could cut ~30–60% of electricity-sector emissions $\approx 7,800$ – $15,600$ mtCO <sub>2</sub> e/yr (from $\sim 25,968$ mt). | Community-scale projects, bill credits, and inclusive financing can deliver lower, more stable bills for at-risk participants. |
| Energy cost savings | Moderate–High    | Reduces exposure to fuel price volatility; long-run LCOE for local renewables often beats imported fuels; savings depend on capital/funding structure.                                                       | Stable bills help households with limited financial buffers; design programs (e.g., community solar shares) to ensure access.  |
| Health benefits     | Moderate         | Fewer local generator emissions and reduced use of backup diesel during shortfalls; indirect air-quality benefits.                                                                                           | Lower exposure to combustion pollutants benefits sensitive groups and communities near generation.                             |
| Resilience          | High             | Microgrids + storage + demand flexibility enhance reliability during storms/cold snaps; reduces outage impacts.                                                                                              | Keeps critical loads (heating, refrigeration, medical devices) online for at-risk households and shelters.                     |
| Disbenefits/risks   | Low–Moderate     | Siting/permitting challenges; variability requires storage/controls; tariff design affects who benefits.                                                                                                     | If not designed with on-bill credits/low-income set-asides, communities may see fewer benefits; ensure consumer protections.   |



## Transportation Efficiency &amp; Electrification

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                               | Community Benefits                                                                                                                                      |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Efficiency, right-sizing, and partial electrification of fleets/passenger vehicles could cut ~15–25% of transportation emissions $\approx$ 8,400–13,900 mtCO <sub>2</sub> e/yr (from ~55,749 mt), with trucks as the largest lever. | Target local business/light-duty fleets, school buses, and high-mileage users; design incentives for access to efficient vehicles and mobility options. |
| Energy cost savings | Moderate         | EVs/hybrids lower fuel + maintenance costs; rural duty cycles and cold-weather range temper savings; efficient ICE upgrades still help.                                                                                             | Reduces transportation cost share for low-income workers and families traveling long distances for services.                                            |
| Health benefits     | Moderate         | Reduced tailpipe pollution and noise; newer vehicles improve safety features.                                                                                                                                                       | Benefits for residents near busy corridors and for children (e.g., cleaner school buses).                                                               |
| Resilience          | Moderate         | Diversifies away from liquid fuel price spikes; vehicle-to-home (V2H) potential in outages if supported; requires charging redundancy.                                                                                              | Lower operating costs improve financial stability; reliable access to charging must extend to rental and multifamily settings.                          |
| Disbenefits/risks   | Moderate         | Upfront costs; winter range/charging performance; sparse charging network; heavier trucks' upfront prices.                                                                                                                          | If incentives and charging aren't equitable, adoption lags; ensure used-EV pathways and rural charging coverage.                                        |





**Flood & Hazard Mitigation Infrastructure**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                | Community Benefits                                                                                          |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Low              | Direct abatement is limited (avoided reconstruction/generator use); order-of-magnitude ~1–3% of total $\approx 1,100\text{--}3,400\text{ mtCO}_2\text{e/yr}$ from avoided losses and emergency fuel. | Not primarily an emissions play, but prevents setbacks that disproportionately harm at-risk households.     |
| Energy cost savings | Low–Moderate     | Avoided damage lowers repair/relocation and emergency energy costs; benefits realized episodically but significant when events occur.                                                                | Reduces catastrophic expenses that can push low-income families into prolonged instability.                 |
| Health benefits     | High             | Lower injury/displacement, reduced mold/contamination exposure post-flood, mental-health protection via faster recovery.                                                                             | Strong gains for residents in vulnerable housing (including mobile homes) and those with limited insurance. |
| Resilience          | High             | Elevation, floodproofing, green infrastructure, improved drainage, and buyouts where appropriate materially reduce disaster impacts.                                                                 | Directly lowers disaster risk for at-risk neighborhoods; protects critical access routes and services.      |
| Disbenefits/risks   | Moderate         | Upfront capital; construction disruption; relocation resistance; risk of uneven protection if projects are not equitably targeted.                                                                   | Without prioritization, benefits may bypass highest-risk households; ensure anti-displacement safeguards.   |

**Communications & Digital Access (Enabler)**

| Outcome             | Potential Impact         | Quantitative / Qualitative Assessment                                                                                                    | Community Benefits                                                                            |
|---------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| GHG reduction       | Low (indirect)           | Digital access itself doesn't abate much, but enables participation in efficiency/renewable programs and trip reduction (tele-services). | Increases program uptake among at-risk households; reduces information gaps.                  |
| Energy cost savings | Moderate (indirect)      | Online enrollment/on-bill tools increase access to incentives and time-of-use savings; telehealth/telework can cut travel energy.        | Helps households navigate rebates/credits and manage bills; reduces missed opportunities.     |
| Health benefits     | Moderate (indirect)      | Better access to emergency alerts, telehealth, and health information; improved continuity of care during events.                        | Addresses barriers faced by uninsured/remote residents; improves outcomes during disruptions. |
| Resilience          | Moderate–High (indirect) | Faster dissemination of warnings, outage info, and aid applications; supports community response networks.                               | Ensures at-risk residents aren't last to know or last served; speeds recovery.                |
| Disbenefits/risks   | Low                      | Subscription/device costs; privacy and digital literacy barriers; connectivity gaps remain in remote areas.                              | Pair access with subsidies, devices, and training to reach at-risk households.                |



### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy costs → Weatherization, efficiency upgrades, and renewable microgrids reduce heating and electricity burdens, directly benefiting cost-burdened families.
- Improved health outcomes → Cleaner air from reduced diesel/industrial emissions lowers asthma, hypertension, and cardiovascular risks.
- Resilience in extreme weather → Reliable microgrids, insulated housing, and diversified transport reduce vulnerability during outages and disasters.
- Economic opportunity → Workforce training in clean energy and infrastructure provides pathways for local employment and skills development.
- Equity in service delivery → Broadband expansion and telehealth access help bridge health care and education gaps for vulnerable populations.

Potential disbenefits if not designed equitably:

- High upfront costs → Without subsidies, at-risk households may be excluded from renewable/efficiency upgrades.
- Risk of inequitable tariffs or cost-shifts → Poorly designed energy programs can increase bills for non-participants.
- Workforce transition challenges → Workers tied to oilfield operations may face job insecurity if not offered retraining.
- Technology reliability risks → Extreme Arctic conditions can undermine performance of new technologies (e.g., batteries).
- Implementation capacity gaps → Limited local contractors or technical expertise could delay or reduce access for at-risk communities.

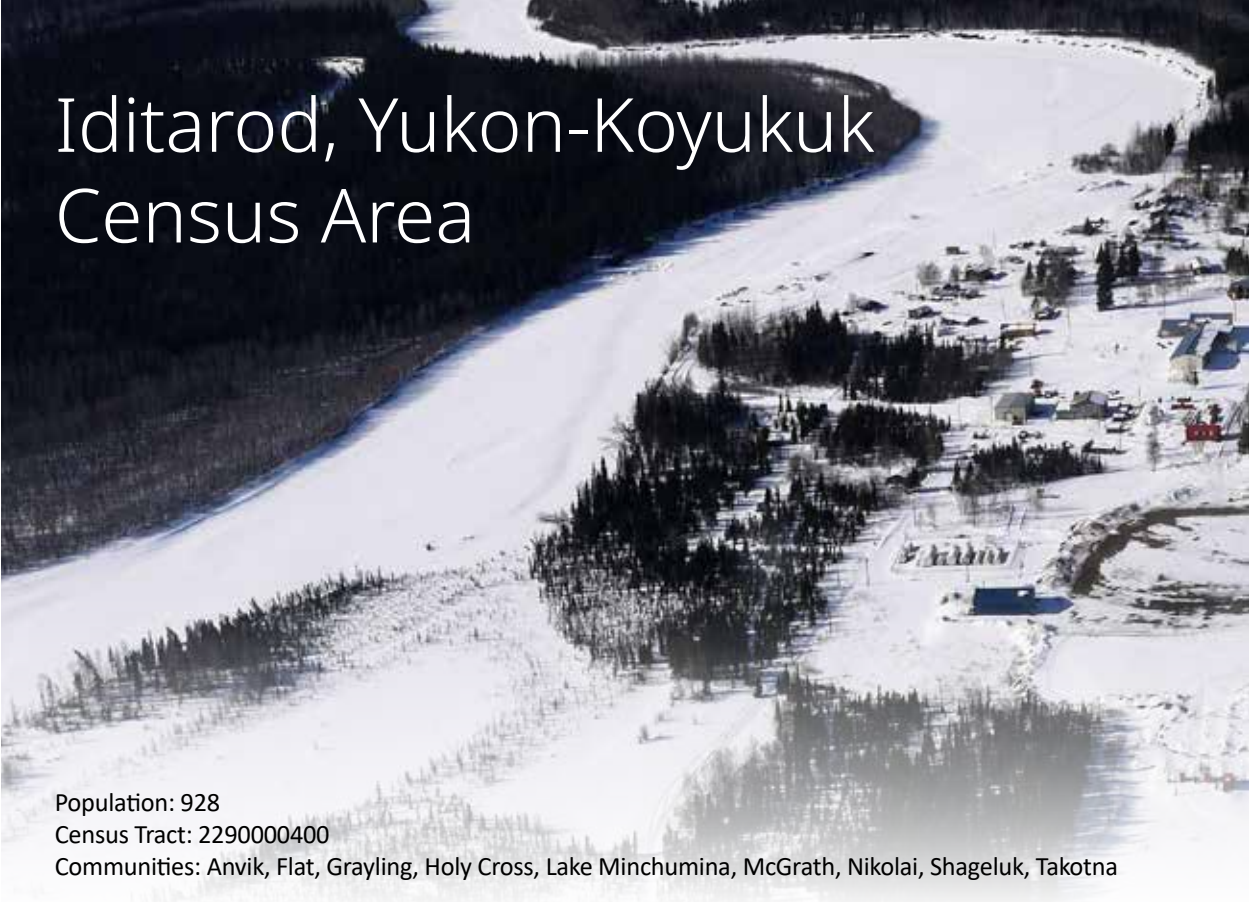
### Path Forward

The Delta region's emissions profile and social conditions make clear that emissions reduction strategies must do more than reduce emissions—they must also deliver tangible improvements to household affordability, health, and resilience. Heating fuels, electricity generation, and transportation are the largest drivers of emissions, but they are also deeply connected to the community's daily challenges: high energy costs, reliance on imported fuels, and limited transportation access. By focusing on building energy efficiency and fuel switching, renewable energy expansion, and transportation improvements, the Delta region can achieve meaningful reductions in emissions while directly addressing the most pressing needs of its residents.

Moving forward, the path for Delta lies in pairing technical solutions with strong program design and community engagement. Prioritizing at-risk households ensures that those most affected by high costs and environmental risks are the first to benefit from investments. Leveraging state and federal resources—such as infrastructure and sustainability programs—will be critical to reducing upfront costs and ensuring sustainable adoption. Finally, resilience must remain central: from flood protection to microgrids, strategies that safeguard homes and essential services will allow the region to thrive even in the face of extreme weather and economic uncertainty. By aligning emissions reduction with improved quality of life, Delta can build a roadmap that both contributes to Alaska's broader sustainability goals and strengthens the well-being of its community.



Delta Junction: By Sabine Löbbbe, wikimedia



# Iditarod, Yukon-Koyukuk Census Area

Population: 928

Census Tract: 2290000400

Communities: Anvik, Flat, Grayling, Holy Cross, Lake Minchumina, McGrath, Nikolai, Shageluk, Takotna

IDITAROD, YUKON-KOYUKUK CENSUS AREA

The Iditarod tract presents a clear picture of both vulnerability and opportunity. High poverty, extreme energy burdens, and aging infrastructure place significant strain on households, while the emissions profile shows that transportation fuels, home heating, and petroleum-based electricity are the primary drivers of criteria pollutants and greenhouse gas (GHG) emissions. These overlapping conditions underscore the importance of strategies that reduce emissions while improving daily life for residents.

The analysis points to three priority areas for action: upgrading housing for energy efficiency, transitioning to renewable and hybrid microgrids, and reducing transportation fuel use through electrification and efficiency improvements. Each of these strategies offers high-impact reductions in emissions alongside meaningful benefits for vulnerable households, from lowering energy costs to improving health and resilience during extreme weather events. Together, they provide a pathway that is both sustainability-focused and community-centered.

Moving forward, the path for the Iditarod tract should focus on scaling these strategies in a phased and coordinated manner. Short-term investments in weatherization and efficiency can deliver immediate relief, while planning and capital development for renewable microgrids can provide long-term stability and emissions reductions. Transportation improvements should begin with targeted fleet electrification and fuel logistics, setting the stage for broader adoption as technologies mature. At every stage, capacity-building and workforce development must be integrated to ensure that benefits are retained locally and that residents are central to shaping and maintaining new systems.

By aligning emissions reductions with improved outcomes for at-risk households, the Iditarod tract can position itself as a model for how rural and remote communities can pursue sustainability goals in a way that strengthens resilience, lowers costs, and supports healthier, more sustainable futures.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Housing Energy Efficiency and Upgrades
2. Renewable and Hybrid Microgrids
3. Transportation Fuel Reduction (Fleet Electrification and Efficient Mobility)

Taken together, these three strategies directly tackle the largest emission sources (industrial combustion, diesel generation, housing fuel use), while producing immediate, tangible benefits for vulnerable residents in the form of lower costs, cleaner air, and more resilient living conditions.

## Emissions Data Overview

Note that these data are for the entire Census Area, which contains four Census Tracts.

Total Modeled Emissions: 96,053 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (29.05%)

- Residential Sector (14.84%)
  - Electricity = 2,896.82 mt CO<sub>2</sub>e (3.02% of total)
  - Natural Gas = 138.65 mt CO<sub>2</sub>e (0.14%)
  - Propane = 5.95 mt CO<sub>2</sub>e (0.01%)
  - Residual Fuel Oil No. 5 = 10,876.15 mt CO<sub>2</sub>e (11.32%)
  - Wood / wood residuals = 339.28 mt CO<sub>2</sub>e (0.35%)
- Commercial Sector (73.20%)
  - Bituminous Coal = 2,579.53 mt CO<sub>2</sub>e (2.69%)
  - Distillate Fuel Oil No. 1 = 4,343.72 mt CO<sub>2</sub>e (4.52%)
  - Propane = 331.60 mt CO<sub>2</sub>e (0.35%)
  - Wood / wood residuals = 12.06 mt CO<sub>2</sub>e (0.01%)
  - Electricity = 6,379.40 mt CO<sub>2</sub>e (6.64%)
- Industrial Sector: 0%

### Transportation (70.95%)

- Fuel types in transportation:
  - Diesel Fuel = 16,741.05 mt CO<sub>2</sub>e (17.43% of total)
  - Motor Gasoline = 51,407.50 mt CO<sub>2</sub>e (53.52%)
  - Electricity = 1.21 mt CO<sub>2</sub>e (negligible)
- By vehicle type (on-road categories):
  - Trucks = 61,539.12 mt CO<sub>2</sub>e (90.3% of transportation emissions)
  - Passenger vehicles = 6,490.64 mt CO<sub>2</sub>e (9.52%)
  - Motorcycles = 120.00 mt CO<sub>2</sub>e (0.18%)

### Electricity Generation

- Electricity consumption and generation mix:
  - Total electricity used: 32,501.88 MWh
  - Coal generation: 325.02 MWh → 104.10 mt CO<sub>2</sub>e (1.12% of electricity-related emissions)
  - Petroleum (oil, diesel, etc.) generation: 31,851.84 MWh → 9,173.33 mt CO<sub>2</sub>e (98.88%)
- Because nearly all generation is petroleum based, the emissions intensity of electricity is high.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- The dominance of transportation (70.95%) shows that mobile sources are by far the largest emissions driver.
- Within stationary combustion, residential fuel oil (Residual Fuel Oil No. 5) is a major contributor.
- Electricity generation is almost entirely petroleum based (not coal) in this region, making it highly carbon intensive.
- The model treats emissions at the census-area level, so Iditarod (a tract within this area) may deviate in both total magnitude and fuel mix (e.g., more or less heating oil use, different vehicle usage).
- Overlap in classification (stationary vs electricity) and allocation assumptions (downscaling) means that these numbers are approximate and should be interpreted as indicative rather than exact.

### Social Determinants of Health

#### Environmental Conditions

- Extreme Weather Change (23.3%): The region faces moderate projected increases in extreme weather, which may strain infrastructure and community resilience.
- Annualized Disaster Loss (\$358,719; 19.89 percentile nationally): Disaster losses are relatively low compared to other regions, but the small population means even modest losses can be destabilizing.
- Air Pollution & Toxic Exposures (0%): Diesel PM, toxic releases, hazardous waste, and RMP facilities are reported as minimal or absent. This indicates a relatively clean environment.
- Pre-1980s Housing (48.1%; 73rd percentile): Nearly half of housing stock predates modern building codes, potentially increasing vulnerability to mold, asbestos, and poor insulation.
- Formerly Used Defense Sites: Presence of historical military sites could pose latent contamination risks.

Implication: The region's environmental health is shaped more by aging infrastructure and exposure to shifting weather patterns than by industrial pollution. Increasing variability in temperature and precipitation will likely intensify existing vulnerabilities linked to housing conditions and infrastructure resilience.

#### Public Health Indicators

- Asthma (3.05%; 19th percentile): Asthma rates are relatively low compared to national levels.
- Cancer (1.4%; 17th percentile): Also low prevalence, suggesting environmental exposures are not a major driver.
- High Blood Pressure (9.5%; 23rd percentile): Below national average, but concerning given access barriers.
- Diabetes (3.75%; 42nd percentile): Higher than average, reflecting diet and access to preventive care.
- Poor Mental Health (4.33%; 24th percentile): Moderate prevalence, but likely underestimated in rural contexts where mental health is underreported.
- Heart Disease (94th percentile nationally): A major health crisis in the region, indicating severe chronic disease burden.
- Life Expectancy (78.2 years): Slightly above national average, but the community still ranks midrange nationally for low life expectancy (53rd percentile).

Implication: Chronic conditions, especially heart disease, represent a serious health burden. Limited healthcare access and high uninsured rates likely exacerbate outcomes, suggesting health resilience is fragile in the face of environmental and economic stressors.



### Socioeconomic Factors

- Poverty (51.5%; 95th percentile): Over half the population lives below 200% of the poverty line, an extremely high rate.
- Education (13.5% without HS diploma; 91st percentile): Educational attainment lags significantly, limiting economic mobility.
- Unemployment (9.8%; 91st percentile): Job opportunities are scarce.
- Housing Cost Burden (22.1%; 36th percentile): Relatively lower than elsewhere, but reflects generally low incomes and low home values (\$55,600; 2nd percentile).
- Uninsured (28.2%; 98th percentile): Extremely high, leaving nearly 1 in 3 residents without health coverage.
- Internet Access (47% without; 99th percentile): Lack of connectivity deeply restricts education, healthcare access, and economic opportunity.
- Energy Burden (9%; 99th percentile): Households spend disproportionate amounts on energy costs, one of the most severe burdens in the country.
- Disability (18.9%; 90th percentile): High rates of disability further strain community health and employment.
- Youth Population (28.5%; 80th percentile): A large share of youth suggests opportunities for long-term investment, but also dependency burdens.
- Elderly Population (13.6%): Midrange, with some elder care needs.

Implication: Socioeconomic vulnerability is extreme, marked by high poverty, poor internet access, and high energy costs. These inequities intersect to create systemic barriers to health and well-being, and will heavily influence how the region engages with sustainability initiatives.

### Transportation Insecurity

- Transportation Access Score (0.01; 43rd percentile): Access to transportation options is severely limited, reflecting geographic isolation.
- Transportation Cost Burden (860%; 100th percentile): This staggering figure reflects extraordinary costs of fuel, shipping, and mobility in the region.
- Traffic Fatalities (2.61 per 100,000; 64th percentile): Above national average, highlighting safety concerns on limited road systems.

Implication: Transportation is one of the most pressing challenges. High costs and low access isolate residents, limit job and healthcare opportunities, and increase vulnerability during emergencies.

### Intersection with Emissions Reduction Planning

The Iditarod region's social determinants of health shape how emissions reduction strategies will be received and implemented:

- Energy Dependence & Cost: With some of the highest energy burdens in the nation, households are highly sensitive to fuel and electricity costs. Any strategy must prioritize affordability and efficiency to avoid worsening inequities.
- Housing Quality: Older housing stock reduces energy efficiency and increases health risks. Upgrading homes could yield both environmental and health co-benefits.
- Health Burdens: Chronic disease, especially heart disease and diabetes, heighten vulnerability to environmental stressors such as heat and food insecurity.
- Economic Marginality: Poverty and unemployment mean sustainability strategies must be linked to job creation, local skill development, and equitable access.
- Infrastructure Isolation: Limited transportation and internet access constrain participation in statewide programs, requiring tailored, community-centered approaches.

Overall: Emissions reduction in the Iditarod region cannot be separated from addressing energy affordability, healthcare access, and socioeconomic inequities. Without careful alignment, sustainability policies could deepen vulnerabilities rather than relieve them.

## Mitigation Strategies

### Energy Efficiency and Housing Upgrades

Housing in the Iditarod tract is both old and inefficient, with nearly half of all homes built before 1980. This translates into a heavy reliance on fuel oil and wood for heat, which not only drives local emissions but also contributes to the extremely high household energy burdens already identified in the social determinants of health. Improving housing stock through weatherization and insulation would dramatically reduce heating demand, making homes more comfortable and affordable to maintain. Replacement of inefficient appliances and outdated stoves would further reduce reliance on fuel oil and wood, with the added benefit of improving indoor air quality. These measures would directly support households with the greatest need by lowering monthly costs, creating healthier living conditions, and reducing exposure during extreme cold events.

### Renewable and Hybrid Microgrids

Electricity in the tract is primarily generated with petroleum fuels, making power both costly and emissions-intensive. Because imported fuel is expensive to transport, the community is particularly well positioned to benefit from renewable integration. Developing hybrid microgrids that combine diesel generation with solar, wind, and battery storage would allow for greater energy security while reducing emissions. These systems would stabilize electricity supply, limit the need for costly fuel imports, and provide resilience during outages. For residents, particularly those in vulnerable households, this would translate into improved reliability of service, lower electricity rates, and more dependable access to power for essential needs like food storage and home heating.

### Transportation Cost and Emission Reductions

Transportation is the largest single source of emissions across the Yukon–Koyukuk region, and the Iditarod tract is no exception. Yet here, transportation is not just a matter of emissions but also of affordability and access, since high fuel costs and limited road infrastructure isolate residents and strain household budgets. Strategies to address these conditions must focus on reducing fuel dependence rather than conventional approaches that assume expansive road systems. Shifting community fleets such as school buses, service trucks, and utility vehicles toward electrification could reduce reliance on gasoline and diesel, provided charging infrastructure is paired with renewable-powered microgrids. Gradual adoption of lower-emission off-road vehicles, such as snowmachines and ATVs, would further decrease fuel demand as alternatives become commercially available. Even near-term improvements to fuel logistics, such as better coordination of supply shipments, could help reduce waste and lower costs. These efforts would ease the financial burden on households, while providing safer and cleaner transportation options that support daily life in the tract.

### Local Workforce and Capacity Building

Unemployment and limited educational attainment are major challenges for the Iditarod tract, and these socioeconomic realities cannot be separated from energy and emissions strategies. Linking mitigation projects to job creation offers a way to maximize both environmental and social outcomes. Training programs focused on weatherization, renewable energy installation, and microgrid maintenance could provide valuable skills while ensuring that infrastructure improvements are supported by local expertise. Because the tract has a relatively large youth population, workforce initiatives that specifically target younger residents would lay the foundation for long-term capacity. This alignment between local job development and sustainability actions would not only reduce reliance on outside contractors but also allow the economic benefits of new energy systems to remain within the community, strengthening long-term resilience.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes for at-risk households in the Iditarod tract extend far beyond emissions reductions. By addressing the intersection of energy costs, health burdens, and infrastructure gaps, mitigation strategies become levers for social and economic resilience. For example, weatherization and housing upgrades not only cut fuel use but also make homes warmer, healthier, and cheaper to maintain — particularly critical for families already devoting an outsized share of income to energy. In a region with high rates of heart disease and disability, clean heating and better indoor air quality are directly tied to lower health risks and improved daily well-being.

Similarly, hybrid microgrids powered by renewable energy reduce exposure to volatile fuel prices and unreliable supply chains. For at-risk households, this translates to fewer outages, more affordable power, and the assurance that critical services like refrigeration for food and medicine remain uninterrupted. Transportation initiatives — whether shifting fleets to electric or improving fuel logistics — also disproportionately benefit lower-income residents who bear the brunt of high travel costs. Coupling these energy measures with local workforce programs ensures that job opportunities are retained within the community, providing younger residents with pathways to stable employment. In combination, these strategies help break cycles of energy poverty, health vulnerability, and economic marginalization, positioning at-risk households at the center of both immediate and long-term benefits.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

#### Energy Efficiency & Housing Upgrades

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                       | Community Benefits                                                                    |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| GHG reduction       | High             | Whole-home weatherization and shell upgrades in cold climates often cut space-heating fuel 20–40% per home; if applied to the older housing cohort, tract-level stationary emissions could fall 10–20% depending on uptake. | Reduces fuel oil/wood use in high-burden homes; lowers exposure to energy insecurity. |
| Energy cost savings | High             | Typical fuel spend reductions 20–40% per upgraded home; simple paybacks vary (5–12 yrs) depending on logistics and material costs.                                                                                          | Eases extreme energy burdens; frees monthly cash flow for essentials.                 |
| Health benefits     | High             | Tightening, ventilation, and clean-burn appliances reduce indoor PM and moisture; expect fewer exacerbations of heart/respiratory illness; safer winter temperatures during outages.                                        | Directly benefits elders, children, and households with chronic disease.              |
| Resilience          | Moderate–High    | Better envelopes retain heat longer during fuel/power interruptions; enables smaller backup systems.                                                                                                                        | Improves safety for medically vulnerable residents during extreme cold.               |
| Disbenefits / risks | Low–Moderate     | Up-front costs; contractor scarcity; retrofit quality risks (e.g., moisture if ventilation isn't addressed); tenant-landlord split-incentives.                                                                              | Mitigated by community-first funding, QA/QC, and landlord participation agreements.   |

**Renewable & Hybrid Microgrids (solar/wind + battery + diesel)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                              | Community Benefits                                                                                 |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Diesel displacement in hybrid systems commonly 30–60% of genset fuel over a year; tract-level electricity emissions could drop 25–50% with staged build-out.       | Cuts petroleum dependence; aligns reliability with affordability for critical services.            |
| Energy cost savings | Moderate–High    | LCOE can fall as fuel haul and O&M decline; net savings depend on capex and grant share. Typical diesel savings 20–50%; payback 7–15 yrs with grants accelerating. | Stabilizes bills; reduces volatility from fuel price spikes that hit low-income homes hardest.     |
| Health benefits     | Moderate         | Lower local exhaust/noise around powerhouses; enables electrification of end uses (e.g., heat pumps) over time, further improving IAQ.                             | Supports clean, reliable power for refrigeration, medical devices, and clinics.                    |
| Resilience          | High             | Storage provides ride-through; diversified supply reduces single-fuel risk; microgrid controls support black-start and islanding.                                  | Fewer outage-related losses for food/medicine; better emergency response.                          |
| Disbenefits / risks | Moderate         | High upfront capital; specialized O&M; performance risk from siting/icing/wind resource; battery replacement cycles.                                               | Mitigate via workforce training, O&M contracts, and reserve funds targeted to at-risk communities. |

**Transportation Cost & Emission Reductions (fleet electrification + efficient off-road + fuel logistics)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                           | Community Benefits                                                                                      |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Transportation is the largest share; electrifying public/service fleets can trim 5–15% of tract-wide transport emissions initially; efficient off-road (or emerging electric) equipment adds incremental gains. | Prioritizing school/clinic/utility fleets brings community-wide benefits quickly.                       |
| Energy cost savings | Moderate–High    | EV fleet OPEX typically 30–60% lower per mile; fuel-logistics optimization can cut delivered fuel use 5–10%. Savings depend on charging powered by lower-cost microgrid kWh.                                    | Reduces pass-through fuel costs in public services; lowers fares/fees that burden low-income residents. |
| Health benefits     | Moderate         | Less exhaust exposure near schools/clinics and in village centers; quieter operations.                                                                                                                          | Benefits children and elders most; improves local air around key services.                              |
| Resilience          | Moderate         | On-site charging plus storage provides mobility even during fuel supply disruptions; critical vehicles can be prioritized.                                                                                      | Preserves access to healthcare, water, fuel, and emergency transport during supply shocks.              |
| Disbenefits / risks | Moderate         | Vehicle availability for Arctic conditions; range impacts in extreme cold; charger siting; higher capex; limited off-road electrics today.                                                                      | Address via phased pilots, heated storage, redundancy, and grants that reduce cost exposure.            |



**Local Workforce & Capacity Building (weatherization, RE install, microgrid O&M)**

| Outcome             | Potential Impact   | Quantitative / Qualitative Assessment                                                                                                                                              | Community Benefits                                                                   |
|---------------------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| GHG reduction       | Moderate (enabler) | Not a direct abatement measure, but raises completion rates and quality across EE/RE projects; can unlock 10–30% more realized savings versus outsourcing with low follow-through. | Ensures at-risk households receive services first and correctly.                     |
| Energy cost savings | Moderate (enabler) | Local crews shorten queues and lower travel mobilization costs; better maintenance sustains savings over time.                                                                     | Keeps program dollars circulating locally; supports stable household incomes.        |
| Health benefits     | Moderate           | Faster delivery of clean-heat/IAQ upgrades; quicker response to hazards (mold, ventilation).                                                                                       | Builds trusted local contacts, improving uptake among vulnerable residents.          |
| Resilience          | High (systemic)    | On-island expertise for repairs and operations reduces downtime; improves disaster response and energy security.                                                                   | Critical for remote at-risk communities where delays are costly and unsafe.          |
| Disbenefits / risks | Low–Moderate       | Training costs; retention; limited project pipeline seasonality; need for certifications.                                                                                          | Mitigate with paid apprenticeships, multi-year pipelines, and regional partnerships. |



### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household costs from reduced fuel use and improved efficiency.
- Health improvements through cleaner indoor air, warmer homes, and fewer chronic disease triggers.
- Greater reliability of electricity and heating, reducing risks during outages or extreme weather.
- Job creation and skills development tied to weatherization, renewable energy, and maintenance.
- Youth opportunities in training and long-term employment pipelines.
- Food and medicine security from stable refrigeration and reliable power supply.
- Increased safety through reduced transportation emissions and better vehicle reliability.
- Community empowerment as local expertise and control over energy systems expand.

Potential disbenefits if not designed equitably:

- High upfront costs may limit participation if programs are not subsidized.
- Technical challenges (battery replacements, cold-weather performance of new tech).
- Contractor or workforce shortages, leading to uneven delivery or delays.
- Equity gaps if renters, remote households, or those with older homes are not prioritized.
- Cultural fit and trust issues if outside solutions are imposed without local input.
- Maintenance and training needs may strain limited local capacity if not sustained.

### Path Forward

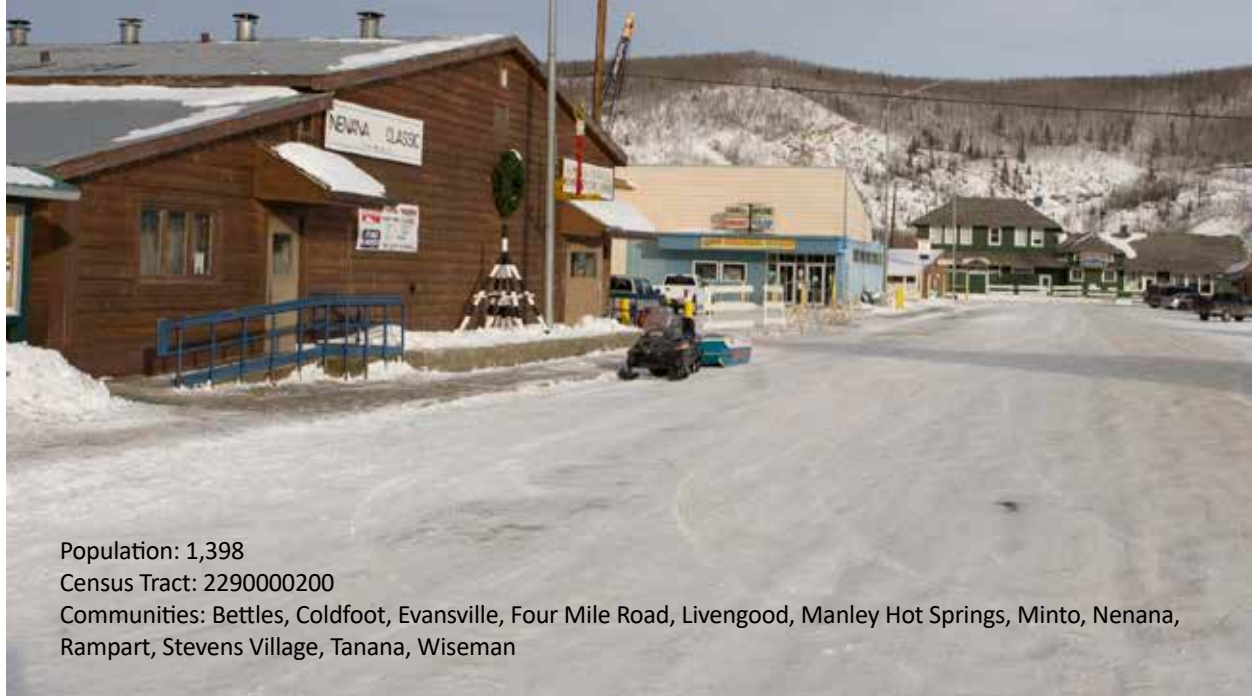
The Iditarod tract presents a clear picture of both vulnerability and opportunity. High poverty, extreme energy burdens, and aging infrastructure place significant strain on households, while the emissions profile shows that transportation fuels, home heating, and petroleum-based electricity are the primary drivers of criteria pollutants and greenhouse gas emissions. These overlapping conditions underscore the importance of strategies that reduce emissions while improving daily life for residents.

The analysis points to three priority areas for action: upgrading housing for energy efficiency, transitioning to renewable and hybrid microgrids, and reducing transportation fuel use through electrification and efficiency improvements. Each of these strategies offers high-impact reductions in emissions alongside meaningful benefits for vulnerable households, from lowering energy costs to improving health and resilience during extreme weather events. Together, they provide a pathway that is both sustainability-focused and community-centered.

Moving forward, the path for the Iditarod tract should focus on scaling these strategies in a phased and coordinated manner. Short-term investments in weatherization and efficiency can deliver immediate relief, while planning and capital development for renewable microgrids can provide long-term stability and emissions reductions. Transportation improvements should begin with targeted fleet electrification and fuel logistics, setting the stage for broader adoption as technologies mature. At every stage, capacity-building and workforce development must be integrated to ensure that benefits are retained locally and that residents are central to shaping and maintaining new systems.

By aligning emissions reduction strategies with improved outcomes for at-risk households, the Iditarod tract can position itself as a model for how rural and remote communities can pursue sustainability goals in a way that strengthens resilience, lowers costs, and supports healthier, more sustainable futures.

# Tanana Flats, Yukon-Koyukuk Census Area



Population: 1,398

Census Tract: 2290000200

Communities: Bettles, Coldfoot, Evansville, Four Mile Road, Livengood, Manley Hot Springs, Minto, Nenana, Rampart, Stevens Village, Tanana, Wiseman

The Tanana Flats tract, within the Yukon–Koyukuk Census Area, faces distinctive challenges tied to energy use, health, and infrastructure in one of Alaska’s most remote regions. Residents experience high energy costs, aging housing, and limited access to transportation and essential services, all of which shape daily life and local resilience. At the same time, emissions from transportation, heating, and petroleum-based power systems contribute significantly to regional totals. These conditions highlight the need for practical strategies that reduce energy and emissions while improving community well-being and economic stability.

This report evaluates a set of mitigation approaches designed specifically for the Tanana Flats region. Drawing on available census-area data and local social and environmental indicators, the analysis assesses potential benefits, risks, and long-term implications for residents. The strategies presented here aim to create pathways that lower household costs, improve health outcomes, and strengthen energy reliability—ensuring that environmental action also delivers lasting improvements in quality of life.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Transportation Efficiency and Electrification
2. Heating Fuel Switching and Deep Energy Retrofits
3. Renewable Microgrids and Diesel Displacement in Power Generation

The biggest sustainability gains will come from transportation reform, heating fuel switching, and renewable microgrids. Together, these three areas cover the bulk of current emissions while delivering the most meaningful cost, health, and resilience benefits for vulnerable communities in Tanana Flats.

## Emissions Data Overview

Note that these data are for the entire Census Area, which contains four Census Tracts.

Total Modeled Emissions: 96,053 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (29.05%)

- Residential Sector (14.84%)
  - Electricity = 2,896.82 mt CO<sub>2</sub>e (3.02% of total)
  - Natural Gas = 138.65 mt CO<sub>2</sub>e (0.14%)
  - Propane = 5.95 mt CO<sub>2</sub>e (0.01%)
  - Residual Fuel Oil No. 5 = 10,876.15 mt CO<sub>2</sub>e (11.32%)
  - Wood / wood residuals = 339.28 mt CO<sub>2</sub>e (0.35%)
- Commercial Sector (73.20%)
  - Bituminous Coal = 2,579.53 mt CO<sub>2</sub>e (2.69%)
  - Distillate Fuel Oil No. 1 = 4,343.72 mt CO<sub>2</sub>e (4.52%)
  - Propane = 331.60 mt CO<sub>2</sub>e (0.35%)
  - Wood / wood residuals = 12.06 mt CO<sub>2</sub>e (0.01%)
  - Electricity = 6,379.40 mt CO<sub>2</sub>e (6.64%)
- Industrial Sector: 0%

### Transportation (70.95%)

- Fuel types in transportation:
  - Diesel Fuel = 16,741.05 mt CO<sub>2</sub>e (17.43% of total)
  - Motor Gasoline = 51,407.50 mt CO<sub>2</sub>e (53.52%)
  - Electricity = 1.21 mt CO<sub>2</sub>e (negligible)
- By vehicle type (on-road categories):
  - Trucks = 61,539.12 mt CO<sub>2</sub>e (90.3% of transportation emissions)
  - Passenger vehicles = 6,490.64 mt CO<sub>2</sub>e (9.52%)
  - Motorcycles = 120.00 mt CO<sub>2</sub>e (0.18%)

### Electricity Generation

- Electricity consumption and generation mix:
  - Total electricity used: 32,501.88 MWh
  - Coal generation: 325.02 MWh → 104.10 mt CO<sub>2</sub>e (1.12% of electricity-related emissions)
  - Petroleum (oil, diesel, etc.) generation: 31,851.84 MWh → 9,173.33 mt CO<sub>2</sub>e (98.88%)
- Because nearly all generation is petroleum based, the emissions intensity of electricity is high.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- The dominance of transportation (70.95%) shows that mobile sources are by far the largest emissions driver.
- Within stationary combustion, residential fuel oil (Residual Fuel Oil No. 5) is a major contributor.
- Electricity generation is almost entirely petroleum based (not coal) in this region, making it highly carbon intensive.
- The model treats emissions at the census-area level, so Tanana Flats (a tract within this area) may deviate in both total magnitude and fuel mix (e.g., more or less heating oil use, different vehicle usage).
- Overlap in classification (stationary vs electricity) and allocation assumptions (downscaling) means that these numbers are approximate and should be interpreted as indicative rather than exact.



## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Vulnerability:** Anticipated changes in extreme weather are moderately high (49.43 percentile), suggesting growing environmental risks.
- **Annualized Disaster Loss:** The region faces disaster-related damages estimated at \$1.26M annually, in the 65th national percentile, indicating above-average vulnerability to natural hazards.
- **Air Quality Risks:** Diesel PM exposure is 0, but air toxics cancer risk is measurable (9.00). Toxic air releases are low (3rd percentile nationally).
- **Hazardous Site Proximity:** Low proximity to hazardous waste and Superfund sites, but former defense sites are present—possible legacy contamination.
- **Infrastructure Exposure:** 37.14% of housing predates the 1980s (50th percentile), suggesting aging infrastructure. 17% of properties are at flood risk, ranking 82nd nationally.
- **Transportation & Aviation:** Proximity to high-volume roads (35th percentile) and airports (very low, 2nd percentile) is limited, reflecting isolation but also reduced direct exposure to pollution sources.

**Implications:** The Tanana Flats region is moderately vulnerable to environmental risks, with significant flood exposure and aging infrastructure. The presence of former defense sites signals potential historical contamination. Environmental stressors will interact with health and socioeconomic vulnerabilities in shaping community resilience.

### Public Health Indicators

- **Chronic Disease Burden:** Low reported prevalence of asthma (2.05%), cancer (1.32%), diabetes (2.43%), and high blood pressure (7.22%). However, heart disease ranks at the 81st national percentile, indicating disproportionate risk.
- **Mental Health:** Poor mental health prevalence is low (2.75%), but could be underreported in rural/isolated populations.
- **Life Expectancy:** Average life expectancy is 76.7 years, but the region ranks at the 67th percentile for low life expectancy, suggesting disparities compared to other regions.

**Implications:** While chronic disease prevalence is relatively low, heart disease and shorter life expectancy indicate systemic health inequities. These may worsen with environmental stressors, reduced access to care, and economic pressures.

### Socioeconomic Factors

- **Poverty & Inequality:** One-third of residents live below 200% of the poverty line (81st percentile). Income inequality is high (GINI index 0.46, 88th percentile).
- **Education & Employment:** 8.4% lack a high school diploma (70th percentile). Unemployment is 5.1% (61st percentile), above national averages.
- **Housing & Affordability:** Median home value is \$85,000 (very low, 11th percentile). Housing cost burden is moderate (16%). Mobile homes make up 5.5% of housing (72nd percentile).
- **Insurance & Access:** Uninsured rate is 25% (96th percentile), indicating extreme gaps in healthcare access. Nearly half (45.1%) lack internet access (98th percentile), limiting telehealth and education.
- **Energy Costs:** Energy burden is 7% (97th percentile), highlighting severe household vulnerability to energy expenses.

**Implications:** Socioeconomic disadvantages—including poverty, inequality, uninsured populations, and high energy burdens—create significant structural vulnerabilities. Limited internet access compounds social and health inequities, making resilience and adaptation more challenging.

### Transportation Insecurity

- **Access Limitations:** Transportation access score is very low (0.45, 77th percentile nationally), indicating significant mobility barriers.
- **Cost Burden:** Transportation costs are relatively high (83rd percentile), reflecting dependence on expensive fuel and long travel distances.
- **Safety Risks:** Traffic fatalities are elevated (5.66 per 100,000, 85th percentile).

Implications: Transportation is a major barrier to accessing healthcare, jobs, and services. High costs and safety risks compound the region's isolation, reinforcing inequities and limiting opportunities for economic mobility.

### Intersection with Emissions Reduction Planning

The social determinants outlined above shape how the Tanana Flats region might perceive and engage in emissions reduction efforts:

- **Energy Burden & Poverty:** Households already face disproportionately high energy costs. Pollution reduction strategies that lower reliance on diesel and reduce heating/fuel expenses could be highly beneficial, but affordability will be central.
- **Health Vulnerabilities:** Heart disease prevalence and shorter life expectancy highlight the need for sustainability measures that reduce cardiovascular risk factors, such as indoor air quality improvements and better access to healthcare.
- **Infrastructure & Flood Risk:** Aging housing stock and high flood risk suggest that environmental hazard mitigation measures must integrate pollution reduction with infrastructure upgrades.
- **Limited Access & Equity Gaps:** High uninsured rates, poor internet access, and transportation barriers could prevent equitable participation in sustainability programs unless addressed directly.
- **Cultural & Regional Context:** As a rural, Indigenous-influenced region with legacy defense sites, sustainability strategies must consider historical context and prioritize local engagement.

Overall Consideration: Emissions reduction planning in the Tanana Flats region must center equity, affordability, and health co-benefits. The severe socioeconomic and infrastructural vulnerabilities suggest that strategies should be designed not only to reduce emissions, but also to alleviate existing burdens on households and improve resilience to environmental hazards.



## Mitigation Strategies

### Addressing Energy Burden and Heating Needs

Households in the Tanana Flats tract face an extremely high energy burden, ranking in the 97th national percentile. Heating costs consume a disproportionate share of income, especially given the reliance on imported fuel oil in this subarctic region. At the same time, emissions inventories for the Yukon-Koyukuk Census Area show that stationary combustion in residential and commercial buildings is responsible for nearly one-third of total emissions, with fuel oil and coal serving as the main sources. Mitigation strategies in this context should emphasize shifting away from fuel oil and coal toward more efficient electric systems, such as cold-climate heat pumps. Distributed renewable energy systems like solar with storage and locally sourced biomass could also reduce dependence on imported fuels. Deep energy efficiency retrofits in older housing, much of which predates the 1980s, would lower heating demand and complement electrification. These measures would directly lower monthly costs, improve indoor air quality, and reduce emissions at the same time.

### Improving Health Outcomes through Indoor Air and Housing

Although asthma and cancer prevalence are reported at relatively low levels, the region has one of the highest rates of heart disease in the country and a shorter average life expectancy. These health conditions are closely tied to environmental exposures, including the combustion of heating oil, coal, and wood, which contribute to cardiovascular stress. The housing stock, with significant portions dating back to the mid-20th century, is also vulnerable to mold, cold drafts, and flood damage. Mitigation measures that focus on weatherization and mold remediation would improve indoor air quality while reducing heating demand. Fuel-switching away from oil and coal would lessen exposure to particulates and toxic air pollutants, which disproportionately affect cardiovascular health. In addition, pairing electrification with flood-resilient retrofits would make homes safer from environmental impacts while lowering emissions. The result would be improved health outcomes for populations who face the highest risks from poor housing quality and environmental stress.

### Transportation and Access Challenges

Transportation is the dominant source of emissions in the Yukon-Koyukuk Census Area, accounting for more than 70 percent of the total, with trucks and personal vehicles burning gasoline and diesel as the largest contributors. In the Tanana Flats tract, transportation costs are high, access is limited, and the region ranks poorly on mobility indicators. This creates a dual burden of elevated emissions and household expenses. Mitigation strategies in this area should focus on improving mobility options while reducing reliance on gasoline and diesel. Expanding community-based transport services using low-emission vehicles, piloting electrified snowmachines, and preparing hub communities for electric vehicle charging infrastructure would be significant steps forward. Freight consolidation and efficiency improvements could also reduce the region's dependence on long-haul trucking. For isolated communities, these shifts would improve affordability and reliability of access to services and goods, while lowering emissions and reducing exposure to diesel particulates.

### Community Energy Resilience and Power Generation

Electricity generation in the census area remains overwhelmingly petroleum-dependent, with nearly 99 percent of emissions tied to petroleum fuels. This dependence leaves households and communities exposed to supply disruptions, volatile fuel prices, and the persistent costs of maintaining aging diesel systems. At the same time, the Interior region of Alaska offers opportunities for distributed renewable generation, including solar during long summer daylight, biomass where sustainable forestry resources exist, and localized hydro potential. Mitigation strategies here should emphasize upgrading microgrids to integrate renewable energy with storage, building community-scale solar systems, and developing sustainable biomass facilities where feasible. These shifts would not only displace petroleum use and

reduce emissions, but also stabilize energy costs, improve grid reliability, and provide local employment in system operations. These investments would translate into greater control over local energy systems and a more secure future free from the volatility of imported fuel.

### Improved Outcomes for Overburdened and Underserved Communities

For at-risk households in the Tanana Flats tract, the greatest gains would come from reducing energy burdens and improving housing conditions. Transitioning from fuel oil and coal to efficient electric heating and renewables would lower household bills, reduce vulnerability to fuel supply interruptions, and improve indoor air quality. Weatherization and electrification of older homes would create healthier, safer living environments while flood-resilient upgrades would protect families from costly damages. These changes directly support better health outcomes, particularly for heart disease and respiratory risks, while also freeing up limited household income for food, healthcare, and education.

Transportation and community energy resilience also hold strong potential to improve everyday life for vulnerable populations. Lowering reliance on gasoline and diesel through electrified vehicles, shared mobility, and freight efficiency would reduce travel costs, improve access to essential services, and enhance safety in a region with elevated traffic risks. Shifting local power generation from petroleum to renewable microgrids would stabilize costs, reduce exposure to volatile markets, and provide communities with more control over their energy systems. Together, these strategies ensure that sustainability actions deliver not only emissions reductions but also tangible, long-term improvements in affordability, health, and resilience for the region's most vulnerable residents.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

#### Energy Burden & Heating Transition (oil/coal → efficient electric + weatherization + distributed renewables)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                      | Community Benefits                                                                                                      |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Stationary combustion ≈ ~29% of area emissions (~28k mt CO <sub>2</sub> e). Even partial fuel-switching and envelope upgrades can capture a sizable share without full adoption.                           | Reduces emissions where households currently rely on high-carbon fuels; aligns sustainability goals with affordability. |
| Energy cost savings | High             | Household energy burden ~7% (very high). Cold-climate heat pumps + deep weatherization typically cut heating load 25–50% depending on shell; solar+storage can offset shoulder-season diesel/electric use. | Largest direct pocketbook benefit; frees income for food, health, and education.                                        |
| Health benefits     | Moderate–High    | Lower indoor PM and NO <sub>x</sub> from oil/coal/inefficient wood; benefits track with reduced cardiovascular and respiratory stress.                                                                     | Improves outcomes where heart-disease risk is elevated and access to care is constrained.                               |
| Resilience          | Moderate–High    | Weatherized, electrified homes with storage ride through outages and fuel supply disruptions; reduces dependence on fuel deliveries.                                                                       | Enhances safety and continuity for households facing physical isolation and high transport costs.                       |
| Disbenefits / risks | Moderate–High    | Upfront costs, contractor capacity limits, winter performance constraints if systems undersized or buildings under-sealed.                                                                                 | Without targeted incentives and turnkey delivery, residents may be left out or bear transition risks.                   |



**Housing & Health Improvements (weatherization, mold remediation, flood-resilient retrofits; paired with electrification)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                             | Community Benefits                                                                                          |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Efficiency measures reduce heating fuel use; impact grows when coupled with electrification.                                      | Efficiency first lowers bills and makes later electrification affordable for at-risk households.            |
| Energy cost savings | High             | Shell upgrades (air sealing, insulation, windows) cut heating demand; durable savings accrue over building life.                  | Lowers monthly bills without behavior change; protects renters and elders in older housing.                 |
| Health benefits     | High             | Moisture and mold remediation plus better ventilation improve indoor air quality; fewer cold-stress events.                       | Tangible gains for children, elders, and those with chronic conditions; supports longer independent living. |
| Resilience          | High             | Flood-hardening (elevation, sealing, drainage) and building durability reduce disaster losses; 17% of properties have flood risk. | Prevents catastrophic losses that at-risk households have least capacity to absorb.                         |
| Disbenefits / risks | Low–Moderate     | Construction disruption; risk of split-incentives in rentals; need quality control to avoid moisture traps.                       | Requires no-cost programs and tenant protections to ensure participation and benefits.                      |

**Transportation Shifts (shared mobility, EV/snowmachine pilots, freight efficiency, charging in hubs)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                  | Community Benefits                                                                                                    |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Transportation ~71% of area emissions (~68k mt CO <sub>2</sub> e); efficiency + electrification of priority segments (fleets, freight, community shuttles) can unlock material reductions without full fleet turnover. | Prioritizing high-mileage use cases yields outsized benefits for cost-burdened travelers and goods movement.          |
| Energy cost savings | Moderate–High    | EV operating costs generally lower than gasoline/diesel; savings depend on local electricity prices and charging access; freight consolidation reduces delivered-goods costs.                                          | Lowers mobility costs if charging is affordable and services are accessible.                                          |
| Health benefits     | Moderate         | Reduced diesel particulates and tailpipe pollution near housing and community corridors; fewer trips in unsafe conditions if shared options exist.                                                                     | Benefits communities facing higher injury risk and limited access to care.                                            |
| Resilience          | Moderate         | Local charging + community transport maintains access during fuel supply issues; diversified mobility options are a backstop.                                                                                          | Improves continuity of access to clinics, groceries, and schools for households without reliable vehicles.            |
| Disbenefits / risks | High (near-term) | Sparse charging, cold-weather performance concerns, high vehicle capex, road and logistics constraints.                                                                                                                | Without subsidies and hub-based infrastructure, at-risk households may face higher costs or limited utility early on. |

### Community Energy Resilience & Power Generation (renewable microgrids + storage; petroleum displacement)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                 | Community Benefits                                                                                         |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Electricity generation $\approx$ ~9% of area emissions (~9k mt CO <sub>2</sub> e); high displacement potential in diesel-reliant microgrids via solar + storage + optimized dispatch. | Community-scale cuts that don't depend on individual household capital.                                    |
| Energy cost savings | Moderate–High    | Renewable penetration reduces diesel run-hours and fuel haul costs; savings scale with storage and controls; stabilizes rates.                                                        | System-level savings can be shared equitably if tariffs and governance center affordability.               |
| Health benefits     | Low–Moderate     | Reduced local generator emissions and noise; indirect health gains via lower energy poverty.                                                                                          | Community-wide benefit, especially for homes near gensets.                                                 |
| Resilience          | High             | Storage + diversified generation improves uptime; less exposure to global fuel price shocks and delivery delays.                                                                      | Critical for remote at-risk communities where outages and price spikes are most harmful.                   |
| Disbenefits / risks | Moderate–High    | High capex, O&M skill needs, seasonal resource variability; performance depends on quality design and local capacity.                                                                 | If financing and O&M training aren't included, systems may underperform and costs can shift to ratepayers. |



Coldfoot: By Scott McMurren, wikimedia

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy and transportation costs free income for food, healthcare, and education.
- Improved indoor air quality and safer housing reduce cardiovascular and respiratory risks, supporting longer and healthier lives.
- Renewable energy and microgrids increase local control and stability, reducing dependence on volatile fuel markets and deliveries.
- Flood and housing retrofits enhance long-term safety and protect families with the least resources from catastrophic losses.
- Expanded mobility and electrification improve access to healthcare, schools, and jobs in isolated areas.

Potential disbenefits if not designed equitably:

- High upfront costs and financing gaps risk excluding households with the least means unless subsidies or turnkey programs are provided.
- Limited local contractor and workforce capacity may delay or raise the cost of implementation.
- Technology adoption barriers—such as cold-weather performance of EVs or specialized heating systems—may pose higher risks in remote Arctic conditions.
- Digital and transport access gaps could prevent some households from participating fully in new programs or accessing benefits.
- If governance or cost-sharing is poorly structured, ratepayers with fewer resources could be disproportionately burdened.

### Path Forward

The Tanana Flats region presents a strong opportunity to align emission reduction with tangible improvements in energy security, housing quality, and public health. Analysis indicates that the most effective strategies will be those that directly address high household energy use, reliance on imported fuels, and transportation inefficiencies, while also enhancing the safety and durability of local infrastructure.

Moving forward, the priority should be to advance three complementary areas of action: reducing transportation emissions and costs through electrification and efficiency, lowering household and community energy use by replacing heating fuels and upgrading building performance, and transitioning local power systems toward renewable microgrids. Together, these approaches cover the majority of emissions while directly reducing household expenses, improving indoor air quality, and enhancing community resilience to environmental impacts.

The path forward will require sustained investment, place-based program design, and strong collaboration with local and tribal governments to ensure that solutions are practical, affordable, and culturally appropriate. Implementation should focus on ensuring broad participation by low-income households through no-cost or low-cost entry points, workforce development to expand local capacity, and governance structures that return savings and stability to the community.





# Upper Yukon, Yukon-Koyukuk Census Area



The Upper Yukon region, located within the Yukon-Koyukuk Census Area of Alaska, is defined by its remoteness, strong cultural ties, and reliance on local resources. Communities across this area face persistent challenges related to high fuel and transportation costs, aging housing, limited digital connectivity, and constrained access to health and economic opportunities. These conditions place additional strain on households and local infrastructure, particularly during periods of extreme weather or when fuel deliveries are delayed.

Energy use across the broader census area is concentrated in two major sectors: transportation and building energy systems. Together, they account for nearly all emissions from the region, reflecting a heavy dependence on diesel and fuel oil for both mobility and heat. This overlap between energy systems, cost burdens, and household well-being highlights the importance of practical solutions that reduce fuel dependence, improve reliability, and lower expenses for residents. The strategies that follow focus on these shared needs—reducing waste, improving efficiency, and strengthening local capacity to manage and maintain essential systems.

## Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Heating & Power Transition (Diesel/Fuel Oil to Local Renewables & Efficient Systems)
2. Building Efficiency & Housing Retrofits
3. Transportation Shifts (Targeted Fleet Electrification, Shared Mobility, Renewable Fuels)

These three strategies are mutually reinforcing. Housing efficiency reduces the scale of renewable heating investment needed. Local renewables and storage can also support fleet electrification. Together, they target the two largest emission drivers (transportation + heating/power) while delivering the greatest financial and health co-benefits for at-risk households.



## Emissions Data Overview

Note that this data is for the entire Census Area, which contains four Census Tracts.

Total Modeled Emissions: 96,053 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (29.05%)

- Residential Sector (14.84%)
  - Electricity = 2,896.82 mt CO<sub>2</sub>e (3.02% of total)
  - Natural Gas = 138.65 mt CO<sub>2</sub>e (0.14%)
  - Propane = 5.95 mt CO<sub>2</sub>e (0.01%)
  - Residual Fuel Oil No. 5 = 10,876.15 mt CO<sub>2</sub>e (11.32%)
  - Wood / wood residuals = 339.28 mt CO<sub>2</sub>e (0.35%)
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  - Bituminous Coal = 2,579.53 mt CO<sub>2</sub>e (2.69%)
  - Distillate Fuel Oil No. 1 = 4,343.72 mt CO<sub>2</sub>e (4.52%)
  - Propane = 331.60 mt CO<sub>2</sub>e (0.35%)
  - Wood / wood residuals = 12.06 mt CO<sub>2</sub>e (0.01%)
  - Electricity = 6,379.40 mt CO<sub>2</sub>e (6.64%)
- Industrial Sector: 0%

### Transportation (70.95%)

- Fuel types in transportation:
  - Diesel Fuel = 16,741.05 mt CO<sub>2</sub>e (17.43% of total)
  - Motor Gasoline = 51,407.50 mt CO<sub>2</sub>e (53.52%)
  - Electricity = 1.21 mt CO<sub>2</sub>e (negligible)
- By vehicle type (on-road categories):
  - Trucks = 61,539.12 mt CO<sub>2</sub>e (90.3% of transportation emissions)
  - Passenger vehicles = 6,490.64 mt CO<sub>2</sub>e (9.52%)
  - Motorcycles = 120.00 mt CO<sub>2</sub>e (0.18%)

### Electricity Generation (8.81%)

- Electricity consumption and generation mix:
  - Total electricity used: 32,501.88 MWh
  - Coal generation: 325.02 MWh → 104.10 mt CO<sub>2</sub>e (1.12% of electricity-related emissions)
  - Petroleum (oil, diesel, etc.) generation: 31,851.84 MWh → 9,173.33 mt CO<sub>2</sub>e (98.88%)
- Because nearly all generation is petroleum based, the emissions intensity of electricity is high.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- The dominance of transportation (70.95%) shows that mobile sources are by far the largest emissions driver.
- Within stationary combustion, residential fuel oil (Residual Fuel Oil No. 5) is a major contributor.
- Electricity generation is almost entirely petroleum based (not coal) in this region, making it highly carbon intensive.
- The model treats emissions at the census-area level, so Upper Yukon (a tract within this area) may deviate in both total magnitude and fuel mix (e.g., more or less heating oil use, different vehicle usage).
- Overlap in classification (stationary vs electricity) and allocation assumptions (downscaling) means that these numbers are approximate and should be interpreted as indicative rather than exact.

## Social Determinants of Health

### Environmental Conditions

- **Extreme Weather Risk:** Anticipated changes in extreme weather are moderately high (54.55 percentile), suggesting exposure to worsening storms, flooding, or temperature extremes.
- **Disaster Loss:** Annualized disaster loss is nearly \$853,000 (48.86 percentile), indicating recurring vulnerability to natural hazards that can impact infrastructure and livelihoods.
- **Air Quality & Toxics:** Diesel PM exposure is reported at 0.00, but air toxics cancer risk is above baseline (9 percentile). Toxic releases and superfund site proximity are very low, but the presence of formerly used defense sites signals potential legacy contamination risks.
- **Housing & Infrastructure Risks:** About 37 pre-1980s homes (48.3 percentile) indicate possible lead, asbestos, or structural vulnerabilities. Eight percent of local properties face flood risk (53 percentile).
- **Transportation Proximity:** Very limited exposure to major roads or airports suggests low ambient air pollution but also indicates isolation.

Implication: Environmental health risks are driven less by industrial contamination and more by extreme weather, aging housing, and legacy defense sites. These factors increase exposure to environmental hazards and reduce the community's ability to prepare for and recover from them.

### Public Health Indicators

- **Chronic Illness:** Asthma (4.1%), cancer (1.8%), and high blood pressure (12.8%) are present but generally lower than national averages. Diabetes prevalence is elevated (5.2%, 61.36 percentile).
- **Mental Health:** Poor mental health affects 5.83% of the population (39 percentile), reflecting notable community health stress.
- **Heart Disease:** Exceptionally high at the 95th national percentile, representing a major health burden that can intersect with environmental stressors.
- **Life Expectancy:** Average life expectancy is 75.09 years, with low life expectancy at the 79th percentile, highlighting regional disparities.

Implication: Health burdens—especially cardiovascular disease and diabetes—suggest that populations are highly sensitive to environmental stressors and may have reduced resilience to environmental impacts such as heat, smoke, and disruptions to subsistence food systems.

### Socioeconomic Factors

- **Poverty:** Over half the population (56.7%) lives below 200% of the federal poverty line (96.6 percentile), creating significant financial precarity.
- **Education:** Nearly 18% of residents lack a high school diploma (96.6 percentile), limiting economic opportunity and adaptive capacity.
- **Employment:** Unemployment is 11.6% (94.3 percentile), signaling structural economic challenges.
- **Housing & Costs:** Median home value is low (\$88,100, 12 percentile). Cost burdens are moderate (20.2%).
- **Insurance & Access:** 14.6% of residents are uninsured (59 percentile). Internet access is severely limited (69.4%, 100th percentile).
- **Energy Burden:** Very high at 8% of household income (99th percentile), exacerbating economic hardship.
- **Demographics:** A relatively young population (30% under 17, 85th percentile) paired with 14% older adults (61st percentile) creates dual challenges of youth services and elder care. Disability prevalence (14.6%) is above average.

Implication: High poverty, unemployment, and extreme energy and internet burdens mean that many households face compounded vulnerability. Limited educational and digital access restrict community engagement in sustainability planning and adoption of clean technologies.

### Transportation Insecurity

- **Access:** Transportation access is extremely low (0.10 score, 49 percentile), underscoring the geographic isolation of the region.
- **Cost Burden:** Transportation costs are disproportionately high (0.31, 98th percentile), straining household budgets.
- **Safety:** Traffic fatalities are high (6.67 per 100,000, 87th percentile), despite low road access, reflecting risk in limited and hazardous travel routes.

Implication: Transportation challenges reinforce isolation, increase reliance on costly fossil fuels, and heighten safety risks. This significantly constrains options for sustainable mobility and equitable environmental adaptation.

### Intersection with Emissions Reduction Planning

- The high energy burden and transportation costs mean that communities are already overextended on fuel and power expenses, making reductions in fossil fuel dependence economically appealing but logistically difficult.
- Health vulnerabilities such as heart disease and diabetes increase sensitivity to environmental and air quality conditions, underscoring the importance of health-focused energy and environmental planning.
- Socioeconomic constraints—poverty, unemployment, lack of internet—will limit participation in complex programs unless outreach is highly accessible and culturally tailored.
- Environmental risks like extreme weather and flood exposure compound socioeconomic precarity, requiring emissions reduction strategies that are also resiliency measures.
- The demographic structure (youth-heavy with significant elders) suggests a need to integrate both long-term sustainability education and immediate protections for vulnerable elders.

## Mitigation Strategies

### Heating and Energy Systems Transition

Upper Yukon communities depend heavily on imported fuels, with limited infrastructure and some of the highest energy burdens in the country (99th percentile). Many households live in older homes that require large amounts of heating fuel, particularly residual fuel oil No. 5 and diesel, which dominate stationary and electricity-related emissions at the census-area level.

For Upper Yukon, this suggests that localized renewable systems (solar with storage, biomass, or small hydro where feasible) and high-efficiency electric heat pumps would have outsized benefits. By lowering household fuel demand and reducing reliance on volatile imports, these measures reduce emissions while directly addressing the crushing household energy burden.

**Improved outcomes:** Reduced household costs free up income for food, health, and education, while lower exposure to combustion improves respiratory and cardiovascular health.

### Building Efficiency and Housing Retrofits

The region has significant stock of pre-1980s housing, with risks of poor insulation and outdated systems. Paired with limited digital access, households may not be able to access standard energy programs. A targeted weatherization and efficiency retrofit program, coordinated through trusted local institutions, would bring direct savings and emissions reductions.

By addressing housing conditions, this strategy lowers utility bills, improves indoor comfort during extreme cold events, and helps residents better withstand environmental hazards. For at-risk residents, building efficiency directly reduces financial strain and increases resilience in the face of worsening weather extremes.

### Transportation Costs and Alternatives

Transportation is the largest source of emissions in the census area (71%), driven by gasoline and diesel for trucks and passenger vehicles. In Upper Yukon, this aligns with local realities: isolation, no major road systems, and heavy dependence on costly fuel shipments by river or air. The transportation cost burden is extreme (98th percentile), showing how acutely households feel these costs.

While widespread electrification of private vehicles may not be immediately feasible due to infrastructure gaps, targeted strategies like electrification of community fleets (school buses, utility vehicles, local transport services) and support for shared or cooperative transport options could begin to shift the balance. Pairing this with improved storage and distribution systems for renewable fuels (e.g., renewable diesel where accessible) would help reduce both emissions and household strain.

Improved outcomes: More reliable and affordable transport improves access to health care, education, and food, while lowering exposure to safety risks in long, hazardous travel routes.

### Community Energy Planning and Workforce Opportunities

With unemployment high (94th percentile) and nearly 18% without a high school diploma, Upper Yukon residents face systemic barriers to economic participation. Linking mitigation efforts with workforce development in energy and housing sectors would have major local benefits. Training residents in weatherization, solar installation, or community microgrid operation allows the region to capture not only lower emissions but also long-term economic value.

Improved outcomes: Creates stable, locally rooted employment while ensuring residents are not just recipients but active participants in the clean energy transition.

### Improved Outcomes for Overburdened and Underserved Communities

Improved outcomes in the Upper Yukon will come from strategies that lower the daily costs of survival while reducing pollution. High energy burdens, housing insecurity, and transportation expenses weigh heavily on households already facing poverty, unemployment, and health disparities. By shifting away from expensive diesel and fuel oil toward cleaner, local energy sources, households can retain more of their limited income for food, health care, and education. Similarly, targeted housing retrofits and efficiency upgrades not only reduce utility costs but also create safer, healthier indoor environments for elders, children, and people with chronic illness—groups that are particularly vulnerable in this region.

Transportation improvements and localized energy planning further strengthen outcomes by reducing dependence on volatile fuel imports and increasing community resilience during extreme weather. When tied to workforce development, these strategies also generate local employment opportunities, offering residents pathways to stable livelihoods in place of reliance on outside contractors. Taken together, these measures do more than reduce emissions—they directly improve economic stability, health, and resilience for vulnerable communities, ensuring that sustainability actions address both environmental and social vulnerabilities at once.





**Benefit (Disbenefit) Quantification or Qualitative Analysis****Heating & Energy Systems Transition (e.g., diesel/fuel-oil to local renewables, high-efficiency electric heat)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                      | Community Benefits                                                                                                                        |
|---------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Stationary + electricity together comprise ~30–40% of census-area emissions; in off-grid communities with petroleum-based generation, local renewables + efficient heat (e.g., heat pumps where viable, biomass district heat, BTU capture) can displace a large share of fuel combustion. | Directly lowers pollution where people live and work; biggest gains accrue to households near generation/heating sources.                 |
| Energy cost savings | High             | Household energy burden is extreme (~8% avg, 99th percentile). Switching from fuel oil/diesel can cut heating energy use/fuel spend 20–50%+ (site-dependent); community power costs decline with reduced diesel burn and fewer deliveries.                                                 | Frees cash in low-income homes for food/health; reduces arrears and shutoff risk.                                                         |
| Health benefits     | High             | Reduced indoor/outdoor combustion lowers particulates and CO/NOx exposure; aligns with very high heart-disease prevalence.                                                                                                                                                                 | Strong benefits for elders, kids, and those with cardiometabolic disease.                                                                 |
| Resilience          | High             | Less reliance on fuel shipments; more stable winter heat/power; storage can buffer outages and extreme weather.                                                                                                                                                                            | Reduces hardship during supply delays and storms that disproportionately affect at-risk households.                                       |
| Disbenefits / risks | Moderate         | High upfront costs; heat pump performance depends on building shell and temps; biomass needs sustainable supply and O&M; technology/watchstanding capacity; potential tariff impacts without good design.                                                                                  | If not paired with subsidies & local training, at-risk households could be last to benefit; cost-shift risk if financing isn't equitable. |



**Building Efficiency & Housing Retrofits (weatherization, insulation, envelope + efficient appliances)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                              | Community Benefits                                                        |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Typical household savings from deep weatherization 20–35%; aggregate impact grows with scale; synergistic with heating transition. | Prioritizing older homes and overcrowded units maximizes impact.          |
| Energy cost savings | High             | Fuel oil savings often 25–40% in cold-climate retrofits; paybacks improve where fuel costs are highest.                            | Reduces monthly bills; improves comfort/safety for elders and children.   |
| Health benefits     | High             | Better ventilation and moisture control reduce mold/IAQ issues; warmer, safer homes reduce winter stress and injuries.             | Strong benefits where chronic illness and respiratory issues are present. |
| Resilience          | High             | Tight, insulated homes ride through outages longer; lower peak loads during cold snaps; reduced need for frequent fuel deliveries. | Cuts hardship during extreme weather and shipping delays.                 |
| Disbenefits / risks | Low–Moderate     | Contractor capacity limits; split-incentive for rentals; improper ventilation can backfire; logistics raise costs.                 | If programs don't cover up-front costs, at-risk participation lags.       |

**Transportation Cost Shifts & Alternatives (targeted fleet electrification, shared services, efficient logistics; renewable diesel where feasible)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                   | Community Benefits                                                                         |
|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Transportation ≈ ~70% of census-area emissions; even partial fleet transitions (school/clinic/utility vehicles) and efficiency can yield sizable cuts; private EV uptake limited by terrain/grid/price. | Community fleets serve everyone (health, education, utilities), delivering broad benefits. |
| Energy cost savings | Moderate–High    | Targeted fleet electrification cuts fuel & maintenance; shared transit reduces household spend; renewable diesel hedges price volatility but cost premiums possible.                                    | Lowers household mobility costs and improves access to jobs/clinics.                       |
| Health benefits     | Moderate         | Less tailpipe pollution in villages; fewer cold-start diesel emissions; safety improves with reliable shared options.                                                                                   | Benefits sensitive groups and those living near roads/depos.                               |
| Resilience          | Moderate         | Reduced dependence on shipped fuels; but requires charging resilience and maintenance capacity; logistics routes still weather-exposed.                                                                 | Reliable community transport during emergencies is critical.                               |
| Disbenefits / risks | Moderate         | Upfront capex for chargers/vehicles; range and cold-weather performance constraints; grid upgrades; fuel availability for alt-fuels.                                                                    | Risk of concentrating benefits in better-served hubs unless siting is equitable.           |

**Community Energy Planning & Workforce Development (local O&M, retrofit crews, energy advisors)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                           | Community Benefits                                                         |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Indirect lever that enables faster, cheaper deployment and sustained performance across sectors; cumulative impact grows with program maturity. | Ensures at-risk communities can implement/maintain systems locally.        |
| Energy cost savings | Moderate–High    | Local crews reduce travel costs and speed repairs; better program design raises uptake and lowers soft costs.                                   | Keeps savings and wages in-community; reduces dependence on outside firms. |
| Health benefits     | Moderate         | Faster fixes for heat/power/IAQ; better outreach to high-risk residents.                                                                        | Tailored services reach households with greatest health needs.             |
| Resilience          | High             | Local capacity shortens outage duration; builds institutional knowledge; improves spare-parts logistics.                                        | Critical for remote at-risk communities facing frequent disruptions.       |
| Disbenefits / risks | Low–Moderate     | Training takes time; retention challenges; steady project pipeline needed to sustain jobs.                                                      | Without committed funding, benefits fade and trained workers leave.        |



### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household costs → Significant savings on heating and transport where energy burdens are extreme.
- Health improvements → Reduced exposure to fuel oil/diesel emissions; safer, warmer housing; lower stress from energy and transport costs.
- Greater resilience → More reliable heat, power, and mobility during extreme weather or fuel supply disruptions.
- Economic opportunity → Workforce training and local energy/housing projects create jobs, keeping value in the community.
- Inclusive participation → Offline outreach and community-based delivery ensure households without internet or financial resources can access programs.

Potential disbenefits if not designed equitably:

- Upfront cost and financing barriers → Without subsidies, at-risk households may be excluded or left behind in upgrades.
- Implementation challenges → Remote logistics, limited contractor capacity, and technology performance (e.g., heat pumps in extreme cold) could slow progress.
- Equity of access → If programs are not carefully targeted, better-resourced households or larger hubs could benefit first, deepening disparities.
- Sustainability of benefits → Workforce programs may falter if long-term funding or project pipelines are not secured.

### Path Forward

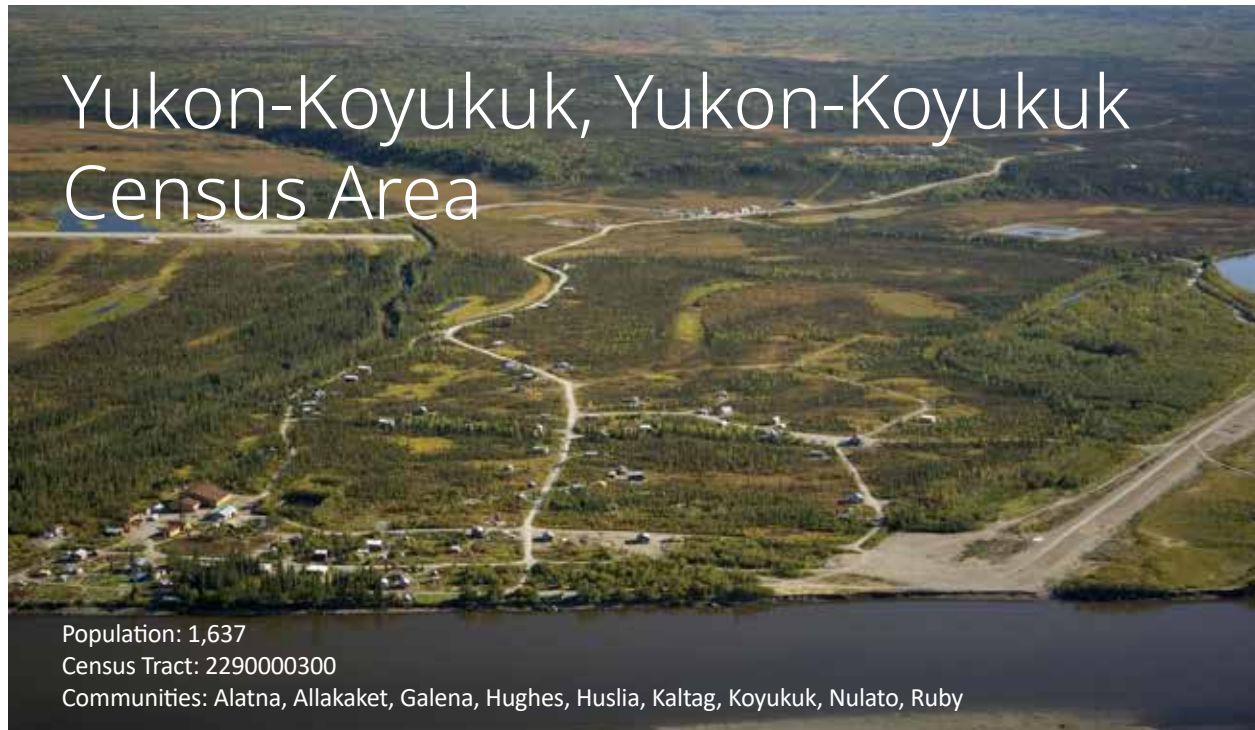
The Upper Yukon's energy and infrastructure challenges are deeply interconnected with the daily experience of its residents. Addressing them requires solutions that reduce costs, improve reliability, and build lasting capacity within the region. The most effective approaches center on three priorities: transitioning heating and power systems to more efficient and locally managed options, improving building performance through targeted retrofits, and reducing transportation costs by modernizing community fleets and improving logistics.

Each of these strategies delivers broad community benefits. More efficient energy systems lower household expenses and reduce dependence on imported fuels. Improved housing creates safer, more comfortable homes and supports better health. Upgraded transportation and power systems enhance mobility, reliability, and economic opportunity. Together, these actions strengthen the foundation for long-term community stability and self-reliance.

The path forward will depend on steady, coordinated investment and local leadership. Early actions such as home weatherization and pilot energy projects can demonstrate quick wins. Medium-term investments in infrastructure, workforce development, and local training will help sustain progress. Over time, building stronger local capacity to operate and maintain these systems will ensure that the benefits of today's improvements continue to support the region for generations to come.







The Yukon–Koyukuk region of Alaska faces a unique intersection of environmental, health, and socioeconomic challenges that shape both community well-being and the region’s contributions to criteria pollutants and greenhouse gas (GHG) emissions. As one of the most rural and remote parts of the state, the area experiences high energy and transportation costs, elevated chronic disease burdens, and limited infrastructure for healthcare and communication. These conditions contribute to disproportionate impacts on communities, who already spend a significant share of their income on energy and transportation while facing barriers to health and opportunity.

Emissions in the census area are heavily concentrated in three domains: transportation and freight, residential heating, and petroleum-based electricity generation. Together, these systems drive both high emission outputs and significant community costs, underscoring the opportunity to align emissions reduction strategies with improved health, affordability, and resilience. By examining the region’s social determinants of health alongside its emissions profile, this roadmap identifies strategies that not only lower carbon pollution but also create tangible, near-term benefits for households under the greatest strain.

This analysis highlights the most impactful actions for GHG reduction while evaluating potential benefits and risks through the lens of community benefits. The goal is to establish a foundation for sustainability planning that improves quality of life, strengthens resilience, and ensures that all communities in Yukon–Koyukuk share in the benefits of the transition to a cleaner, more sustainable energy future.

### Overall Assessment

Most impactful, high-benefit strategies for emissions reduction and community co-benefits:

1. Transportation & Freight Transition
2. Residential Heating Transition (Fuel Oil to Clean Heat)
3. Community Microgrids and Clean Power Generation

In short: freight/transport fuels, residential heating, and microgrids/clean generation are the top three levers for cutting emissions in Yukon–Koyukuk, with strong co-benefits for cost savings, health, and resilience.

## Emissions Data Overview

Note that these data are for the entire Census Area, which contains four Census Tracts.

Total Modeled Emissions: 96,053 metric tons CO<sub>2</sub>e (mt CO<sub>2</sub>e) from all sectors combined.

### Stationary Combustion (29.05%)

- Residential Sector (14.84%)
  - Electricity = 2,896.82 mt CO<sub>2</sub>e (3.02% of total)
  - Natural Gas = 138.65 mt CO<sub>2</sub>e (0.14%)
  - Propane = 5.95 mt CO<sub>2</sub>e (0.01%)
  - Residual Fuel Oil No. 5 = 10,876.15 mt CO<sub>2</sub>e (11.32%)
  - Wood / wood residuals = 339.28 mt CO<sub>2</sub>e (0.35%)
- Commercial Sector (73.20%)
  - Bituminous Coal = 2,579.53 mt CO<sub>2</sub>e (2.69%)
  - Distillate Fuel Oil No. 1 = 4,343.72 mt CO<sub>2</sub>e (4.52%)
  - Propane = 331.60 mt CO<sub>2</sub>e (0.35%)
  - Wood / wood residuals = 12.06 mt CO<sub>2</sub>e (0.01%)
  - Electricity = 6,379.40 mt CO<sub>2</sub>e (6.64%)
- Industrial Sector: 0%

### Transportation (70.95%)

- Fuel types in transportation:
  - Diesel Fuel = 16,741.05 mt CO<sub>2</sub>e (17.43% of total)
  - Motor Gasoline = 51,407.50 mt CO<sub>2</sub>e (53.52%)
  - Electricity = 1.21 mt CO<sub>2</sub>e (negligible)
- By vehicle type (on-road categories):
  - Trucks = 61,539.12 mt CO<sub>2</sub>e (90.3% of transportation emissions)
  - Passenger vehicles = 6,490.64 mt CO<sub>2</sub>e (9.52%)
  - Motorcycles = 120.00 mt CO<sub>2</sub>e (0.18%)

### Electricity Generation

- Electricity consumption and generation mix:
  - Total electricity used: 32,501.88 MWh
  - Coal generation: 325.02 MWh → 104.10 mt CO<sub>2</sub>e (1.12% of electricity-related emissions)
  - Petroleum (oil, diesel, etc.) generation: 31,851.84 MWh → 9,173.33 mt CO<sub>2</sub>e (98.88%)
- Because nearly all generation is petroleum based, the emissions intensity of electricity is high.

### Other Sectors (Industrial Process, Waste & Wastewater, Agriculture & Land-Use): 0%

- Not included in this dataset.

### Key Takeaways

- The dominance of transportation (70.95%) shows that mobile sources are by far the largest emissions driver.
- Within stationary combustion, residential fuel oil (Residual Fuel Oil No. 5) is a major contributor.
- Electricity generation is almost entirely petroleum based (not coal) in this region, making it highly carbon intensive.
- The model treats emissions at the census-area level, so Yukon-Koyukuk (a tract within this area) may deviate in both total magnitude and fuel mix (e.g., more or less heating oil use, different vehicle usage).
- Overlap in classification (stationary vs electricity) and allocation assumptions (downscaling) means that these numbers are approximate and should be interpreted as indicative rather than exact.

## Social Determinants of Health

### Environmental Conditions

#### *Extreme Weather and Disasters*

- Anticipated changes in extreme weather: 50.57 (above average risk).
- Annualized disaster loss: \$823,990.60 (45th percentile nationally).
- Properties with flood risk: 0% (low local property-level risk).
- Proximity to hazardous facilities/sites: 0% across all categories, suggesting low current industrial pollution risks.
- Legacy risks: Contains Formerly Used Defense Sites, which may carry historical contamination issues.

Implications: While the region avoids many industrial environmental hazards, it faces growing risks from extreme weather. Legacy military sites may add localized concerns. This creates vulnerabilities that intersect with energy and housing resilience planning.

### Public Health Indicators

#### *Chronic Disease Burden*

- Asthma prevalence: 3.94% (34th percentile).
- Diabetes prevalence: 4.84% (57th percentile).
- Heart disease prevalence: 92nd percentile — a severe outlier compared to national averages.
- High blood pressure: 12.18% (37th percentile).
- Cancer prevalence: 1.9% (32nd percentile).

#### *Mental and Overall Health*

- Poor mental health prevalence: 5.51% (36th percentile).
- Life expectancy: 75.1 years, but low life expectancy ranked at 79th percentile nationally, meaning many experience shorter lifespans.

Implications: The area faces a high burden of cardiovascular disease and shorter life expectancy. Combined with other moderate chronic health risks, this places stress on health systems and makes the population more sensitive to environmental stressors like poor air quality or disruptions to subsistence lifestyles.

### Socioeconomic Factors

#### *Poverty and Inequality*

- Below 200% Federal Poverty Line: 46.7% (93rd percentile).
- Unemployment: 12.3% (95th percentile).
- Income inequality (GINI Index): 0.46 (88th percentile).

#### *Education and Access*

- No high school diploma: 10.4% (81st percentile).
- Uninsured: 22.7% (90th percentile).
- Limited internet access: 52.7% (99th percentile).

#### *Housing and Energy*

- Median home value: \$76,600 (7th percentile).
- Energy burden: 7% of income (97th percentile).
- Disability prevalence: 17.1% (85th percentile).

Implications: Economic insecurity, high unemployment, and poor access to internet and health insurance create significant barriers to health and opportunity. Extremely high energy burden signals a critical issue: households spend a disproportionate share of income on fuel and heating, which ties directly to sustainability and energy policy considerations.

## Transportation Insecurity

### Access and Cost

- Transportation access score: 0.03 (44th percentile — relatively low).
- Transportation cost burden: 0.19 (91st percentile — very high).
- Traffic fatalities: 0% (no major road-related safety issues).

**Implications:** The cost of transportation is disproportionately high, which is consistent with remote, rural, road-limited communities reliant on fuel imports and air transport. This adds to economic stress and dependency on fossil fuels for mobility and supply chains.

## Intersection with Emissions Reduction Planning

The social determinants in Yukon-Koyukuk suggest that sustainability policy must be deeply tied to equity and resilience:

- **High Energy Burden:** Residents already spend heavily on fuel and heating. Emissions reduction strategies must prioritize affordable, reliable, and clean energy alternatives to ease this burden.
- **Health Sensitivities:** High cardiovascular disease prevalence and low life expectancy mean the population may be more vulnerable to air pollution or environmental stressors. Clean air and resilient health infrastructure will be critical.
- **Economic Fragility:** Poverty, unemployment, and limited internet access may hinder participation in transition programs unless they are locally tailored and well-supported.
- **Transportation Costs:** Reliance on costly transportation fuels creates both economic and environmental vulnerabilities. Strategies that address freight, air transport, and rural logistics will be crucial.
- **Community Vulnerability:** With historical contamination sites, a large youth population (26%), and a notable elder share (12.5%), sustainability planning must address both future opportunity and intergenerational health.





## Mitigation Strategies

### Transportation and Freight Transition

The largest emissions source in Yukon–Koyukuk comes from transportation, particularly heavy-duty trucks and diesel freight. Because these vehicles also form the backbone of supply chains in remote Alaska, reductions here must be carefully designed not to increase costs or restrict access. Strategies could include phased adoption of hybrid or renewable diesel for freight carriers, coupled with investments in logistics efficiency such as consolidated shipments and optimized routing. Expanding air and water freight alternatives powered by cleaner fuels may also help reduce dependency on long-haul diesel trucking. For at-risk populations, these changes could stabilize the price of essential goods, which are highly sensitive to fuel costs, and reduce local exposure to diesel particulates that worsen heart and lung disease.

### Residential Energy and Heating

Households in the region face some of the highest energy burdens in the nation, with many residents paying a disproportionate share of income for fuel oil heating. Transitioning from residual fuel oil No. 5 to alternative systems—such as high-efficiency electric heat pumps adapted for cold climates, biomass district heating where forest resources allow, or community-scale geothermal—would directly reduce emissions while lowering household costs over time. For at-risk families, these upgrades could reduce heating insecurity, improve indoor air quality, and lower risks of respiratory illness linked to burning older fuel oils. Subsidized retrofit programs, community energy co-ops, and tribal-led clean heating initiatives could be designed to ensure participation by low-income households, renters, and elders.

### Power Generation and Microgrids

Nearly all electricity in the census area is generated from petroleum fuels, creating a dual burden of high costs and high emissions. Deployment of renewable microgrids—solar plus battery storage, small-scale wind, or hybrid systems integrated with existing diesel generators—could dramatically reduce fuel dependency while improving reliability in remote communities. Reducing diesel use for power also decreases vulnerability to supply chain disruptions, which disproportionately affect vulnerable residents when outages or shortages occur. Cleaner, more resilient power systems can also support new economic activity, such as electrification of transport and local enterprise development, providing opportunities for at-risk communities to benefit from lower long-term energy prices and improved service reliability.

### Transportation Access and Mobility

Transportation insecurity is another major social determinant in Yukon–Koyukuk. With costs among the highest in the nation, even small increases in fuel prices strain household budgets. Emissions reduction strategies that expand access to lower-cost, lower-emission travel options—such as electrified school and community shuttles, community-run ride-share fleets using hybrid vehicles, or subsidies for efficient snowmobiles and boats—could directly reduce household transportation costs. For at-risk residents, this would mean improved mobility for work, education, and healthcare access, while also reducing dependence on expensive, carbon-intensive gasoline.

### Building Weatherization and Efficiency

Given the high proportion of older housing stock and significant poverty rates, investing in building weatherization programs (insulation, window upgrades, roof sealing) would address multiple challenges at once. Reduced heating demand lowers emissions and decreases household energy burden. Improved housing conditions also reduce health risks, particularly for cardiovascular and respiratory illness, which are already elevated in the region. For at-risk households, this is a pathway to immediate comfort, reduced bills, and longer-term resilience against extreme cold events.

### Improved Outcomes for Overburdened and Underserved Communities

Improving energy systems and housing conditions in Yukon–Koyukuk would deliver immediate benefits for at-risk communities, who face some of the highest energy burdens in the country. Transitioning away from fuel oil heating through renewable microgrids, weatherization, and efficient alternatives would lower household costs, making energy more affordable and reliable. For residents most vulnerable to economic stress, these changes would mean more money available for essentials like food and healthcare, safer and more comfortable homes during extreme cold, and improved indoor air quality that reduces risks of respiratory illness. Cleaner local power systems also cut reliance on fragile supply chains, strengthening resilience against fuel shortages or price spikes that disproportionately affect low-income households.

Transportation-focused strategies would also improve outcomes by reducing costs and health risks. Heavy diesel use dominates regional emissions, and shifting toward cleaner freight and local mobility options would ease dependence on imported fuels while expanding affordable access to work, education, and healthcare. For at-risk residents, this means more reliable mobility, fewer exposure risks from diesel exhaust, and greater participation in community and economic life. Together, these mitigation strategies don't just cut emissions—they directly improve health, stability, and opportunity for the region's most vulnerable populations.

### Benefit (Disbenefit) Quantification or Qualitative Analysis

#### Transportation & Freight Transition (diesel/gasoline to cleaner fuels, routing/logistics efficiency)

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                                                                                           | Community Benefits                                                                                                                                   |
|---------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Largest source (~71% of total). Even a 10–20% cut in truck/freight fuel use via routing, load consolidation, driver aids, and limited cleaner fuels can yield ~7–14% total-emissions reduction. Pilots with renewable diesel or hybridization can drive deeper cuts without new infrastructure. | Cuts emissions where they're concentrated; earlier benefits accrue to communities bearing highest delivered-goods costs.                             |
| Energy cost savings | Moderate         | Fuel efficiency and route optimization typically save 5–15% fuel; renewable diesel usually costs more than ULSD but can be offset by efficiency and reliability gains. Savings pass through if freight rates stabilize.                                                                         | Lower volatility in delivered goods' prices benefits households with thin budgets; helps remote at-risk communities sensitive to freight surcharges. |
| Health benefits     | High             | Less diesel combustion reduces PM <sub>2.5</sub> /NO <sub>x</sub> near roads/depots and around communities, aligning with high cardiovascular burden.                                                                                                                                           | Reduced exposure for children/elders and those with heart disease; fewer exacerbations and avoided medical travel costs.                             |
| Resilience          | Moderate         | Efficiency + diversified fuels reduce supply-chain fragility; fewer emergency fuel lifts.                                                                                                                                                                                                       | Fewer stockouts and price shocks safeguard access to food/medicine in low-income villages.                                                           |
| Disbenefits / risks | Moderate         | Renewable fuels' supply/logistics constraints; higher near-term costs; technology risk in extreme cold; limited EV HD truck options.                                                                                                                                                            | If costs aren't contained, freight rates could rise; ensure protections so communities aren't paying more for essentials.                            |

**Residential Energy & Heating Transition (fuel oil → cold-climate heat pumps, biomass district heat, geothermal where viable)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                               | Community Benefits                                                                                                              |
|---------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | High             | Residential stationary fuels ≈ ~15% of total emissions. Converting 30–50% of homes to efficient systems could cut ~5–8% of total emissions, more where fuel oil dominates.                          | Direct, local reductions tied to homes with the highest fuel use; strong alignment with households in older or leakier housing. |
| Energy cost savings | High             | Heat pumps (when grid or microgrid power is reasonably priced) and well-run biomass/geothermal can lower annual heating costs ~20–40% vs. fuel oil; deeper savings when paired with weatherization. | Largest relief for those with extreme energy burden; frees cash for food, meds, and school needs.                               |
| Health benefits     | High             | Reduced indoor combustion byproducts; steadier indoor temps; fewer mold/moisture issues when paired with envelope fixes.                                                                            | Benefits accrue to respiratory- and heart-vulnerable residents and elders.                                                      |
| Resilience          | High             | Fewer winter fuel deliveries; diversified heat sources; less risk from price spikes or river/air disruptions.                                                                                       | Greater heating security for households least able to absorb outages or delays.                                                 |
| Disbenefits / risks | Moderate         | Upfront costs, contractor capacity, and cold-climate performance requirements; biomass supply chains must be sustainable; electricity price risk if generation remains petroleum-based.             | Without incentives and protections, low-income renters/homeowners could be left behind; ensure no bill shocks.                  |



**Power Generation & Community Microgrids (solar/wind + storage hybrids to displace diesel generation)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                                                              | Community Benefits                                                                                                               |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate–High    | Electricity generation $\approx$ ~9% of total, mostly petroleum. Replacing 40–70% of diesel kWh with renewables/storage could yield ~4–6% total-emissions cuts; also enables future transport/heating electrification multipliers. | Cleaner, cheaper kWh unlocks other benefits (heat pumps, EV shuttles).                                                           |
| Energy cost savings | Moderate–High    | Levelized cost of renewable microgrids can undercut flow-in diesel over asset life; savings rise with fuel price volatility; O&M and storage cycling matter.                                                                       | Lower, more predictable tariffs support households on fixed or low incomes.                                                      |
| Health benefits     | Moderate         | Less diesel runtime lowers local air toxics/noise around gen-sets; indirect health gains via enabling clean heat/mobility.                                                                                                         | Community-wide benefits, including for homes near powerhouse sites.                                                              |
| Resilience          | High             | Storage provides ride-through; renewables reduce dependence on fuel deliveries; black-start capability and sectionalization limit outages.                                                                                         | Critical for villages where outages disproportionately harm low-income residents.                                                |
| Disbenefits / risks | Moderate         | Capital intensity; need for trained operators; winter solar/wind variability; battery end-of-life logistics.                                                                                                                       | If capital recovery raises tariffs short-term, communities could face affordability issues—design tariffs + subsidies carefully. |





**Transportation Access & Mobility (community shuttles, shared efficient vehicles, targeted electrification for local trips)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                                                        | Community Benefits                                                                                        |
|---------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Local mobility is a smaller slice than freight. Electrifying school/community shuttles and right-sizing fleets can trim ~1–3% of total emissions now, more as charging and microgrids scale. | Benefits concentrate where residents rely on shared rides for work/healthcare.                            |
| Energy cost savings | Moderate         | Lower per-mile energy cost for electric/efficient vehicles vs. gasoline; pooled services reduce per-trip costs ~10–30% for riders.                                                           | Improves affordability of essential travel for low-income residents without cars or with high fuel costs. |
| Health benefits     | Moderate         | Less tailpipe exposure near schools/centers; fewer missed appointments due to cost/vehicle issues.                                                                                           | Gains for children, elders, and medically vulnerable at-risk residents.                                   |
| Resilience          | Moderate         | Community-managed fleets provide mobility during fuel shortages/outages if paired with resilient power; redundancy vs. single-vehicle dependency.                                            | Ensures access to clinics and supply points during disruptions.                                           |
| Disbenefits / risks | Low–Moderate     | Cold-weather range limits; charger siting; small-fleet economics; program sustainability if ridership fluctuates.                                                                            | Risk of excluding the hardest-to-reach households unless routes/fares are inclusive.                      |

**Building Weatherization & Efficiency (insulation, air sealing, windows, cords with ventilation/moisture control)**

| Outcome             | Potential Impact | Quantitative / Qualitative Assessment                                                                                                                | Community Benefits                                                                                     |
|---------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| GHG reduction       | Moderate         | Cutting heat load ~20–40% in a material share of homes can deliver ~3–6% total-emissions reduction (also multiplies benefits of clean-heat systems). | Targets leakiest homes first—often low-income and older stock.                                         |
| Energy cost savings | High             | Typical space-heating fuel savings ~15–35%; fastest payback among demand-side options; works regardless of heating fuel.                             | Immediate bill relief for households with highest energy burden.                                       |
| Health benefits     | High             | Warmer, drier homes reduce respiratory triggers and cardiovascular stress in extreme cold; fewer mold/moisture issues.                               | Strong benefits for children and elders in crowded or substandard housing.                             |
| Resilience          | High             | Better envelopes hold heat longer during outages; smaller systems suffice; less risk from delayed fuel deliveries.                                   | Critical protection for residents least able to relocate or pay emergency costs.                       |
| Disbenefits / risks | Low              | Requires contractor capacity; risk of poor ventilation if not designed well; modest disruption during retrofits.                                     | Ensure no out-of-pocket barriers; provide tenant protections so improvements don't trigger rent hikes. |

### Cross-Cutting Community Benefits and Disbenefits

Across all strategies, benefits for community benefits include:

- Lower household energy costs → Reduces extreme energy burden, freeing income for essentials.
- Improved indoor environments → Healthier homes with less mold, better air quality, and safer temperatures.
- Cleaner local air → Reduced diesel and fuel oil use lowers risks for heart and lung disease.
- More reliable power and heat → Microgrids and weatherized homes reduce risks from outages and fuel shortages.
- Affordable mobility → Expanded transport access helps residents reach jobs, healthcare, and education.
- Economic opportunity → New jobs and skills in renewable energy, weatherization, and fleet management can stay in the community.

Potential disbenefits if not designed equitably:

- High upfront costs → Without subsidies, at-risk households may be unable to participate in upgrades.
- Technology risks in cold climates → New systems (EVs, heat pumps, batteries) must be proven for Arctic conditions.
- Program access gaps → Renters, elders, or remote villages risk being excluded if programs don't target them.
- Short-term tariff or fuel cost spikes → Transitions could temporarily raise prices if financing and protections aren't in place.
- Maintenance and workforce challenges → Limited local capacity for installation and upkeep could slow adoption or create inequities.

### Path Forward

The Yukon–Koyukuk region presents a compelling case for integrating emissions reduction with strategies that directly improve daily life for residents. The region's emissions are heavily concentrated in transportation, residential heating, and petroleum-based electricity generation—sectors that also drive high household costs, health burdens, and vulnerability to supply chain disruptions. Addressing these sectors offers the greatest potential for measurable emissions reductions while simultaneously improving outcomes.

The most impactful strategies identified—transitioning freight and transportation fuels, replacing fuel oil heating with clean alternatives, and deploying renewable microgrids—can be phased and paired with building weatherization and mobility improvements to maximize both emissions reductions and community benefits. These interventions not only cut carbon but also reduce energy insecurity, improve indoor and outdoor air quality, lower costs for households with the highest burdens, and create a more resilient foundation for future generations.

The path forward should focus on practical, community-centered implementation. Key next steps include:

- Prioritizing high-impact strategies that target transportation, heating, and power generation.
- Designing programs with explicit attention to needs, ensuring affordability, accessibility, and protections for renters, elders, and remote communities.
- Building local capacity for installation, maintenance, and management of clean energy systems, so that economic and employment benefits remain in the region.
- Leveraging co-benefits in health and resilience as part of funding and policy design, to ensure sustainability investments deliver multiple returns.
- Sequencing investments so that near-term measures (weatherization, efficiency, logistics improvements) lay the groundwork for long-term transitions (full electrification and renewable supply).

By aligning emissions reduction with improved outcomes for at-risk households, Yukon–Koyukuk can pursue sustainability strategies that are not only environmentally effective but also socially responsive. This dual focus will help ensure that sustainability actions strengthen the region's resilience, reduce economic and health disparities, and support a more sustainable and equitable future for all communities across the census area.