Alaska State Greenhouse Gas Emissions Inventory

1990 – 2010

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Non-Point Mobile Sources Program

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Contents

Exhibit List

Acronyms

CCS	Center for Climate Strategies
CH_4	Methane
CO_2	Carbon dioxide
DEC	Department of Environmental Conservation
DOE	Department of Energy
EIA	Energy Information Administration
EPA	Environmental Protection Agency
GHG	Greenhouse gas
GHGRR	Greenhouse Gas Reporting Rule
HFC	Hydrofluorocarbons
MT	Metric tons
N_20	Nitrous oxide
ODS	Ozone depleting substance
PCE	Power Cost Equalization Program
PFC	Perfluorocarbons
SF_6	Sulfur hexafluoride
SIT	State Inventory Tool
T&D	Transmission and distribution

Summary

This report describes Alaska's greenhouse gas (GHG) emissions from anthropogenic sources from 1990 through 2010. This report is based on EPA's 2013 State Inventory Tool (SIT) using modified inputs for Alaska. The tool calculates emissions across all economic sectors for the six Kyoto greenhouse gases based on individual state inputs. Exhibit 1 shows the results by sector.

The industrial sector, including the oil and gas industries, produces the most greenhouse gas emissions in the state, followed by the transportation, the residential and commercial, and the electric generation sectors. The waste, agriculture, and industrial process sectors each produce relatively small quantities of greenhouse gases in Alaska.

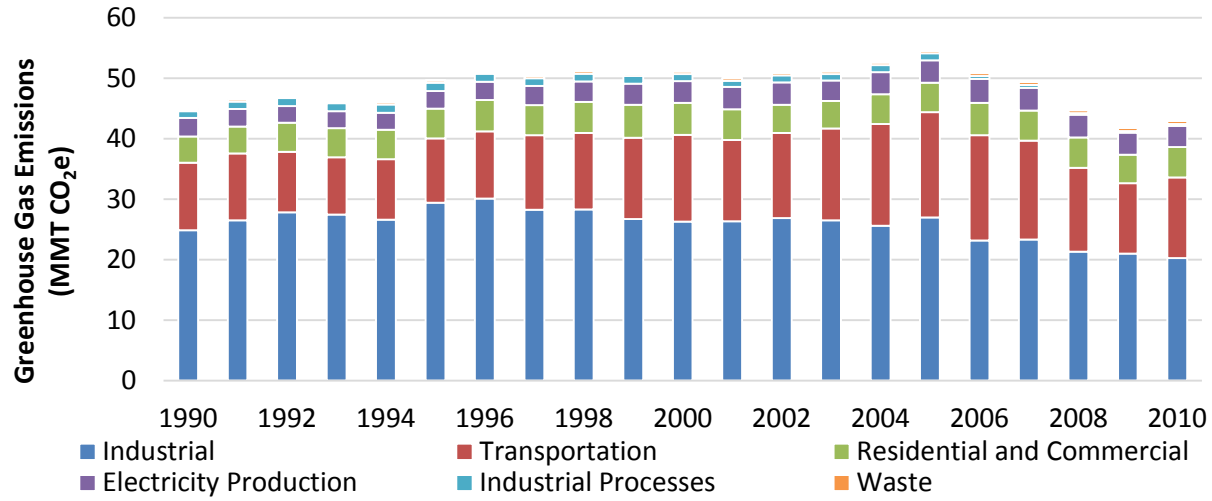
Overall, from about 1995 through 2003, greenhouse gas emissions were quite stable at about 50 million metric tons of carbon dioxide equivalents. Emissions peaked in 2005 and by 2009 had declined by about 23%. Some of this decline is likely due to the recent economic recession as emissions increased in 2010.

According to the Energy Information Administration (EIA), based on total energy related carbon dioxide emissions, Alaska ranks the 38th in emissions among the states. On a per capita basis, the state ranks third in the nation.[1]

Methodology Note

The Center for Climate Strategies prepared the first greenhouse gas inventory report for Alaska; the report was finalized in July 2009. Because of slight methodological changes, the numerical results in this report should not be directly compared to the results in the previous report. Nonetheless, the overall picture of greenhouse gas emissions is quite similar between the two reports.

Exhibit 1 – Annual Greenhouse Gas Emissions by Sector



[1] http://www.eia.gov/environment/emissions/state/analysis/

Background

Alaska's first statewide greenhouse gas (GHG) inventory reported emissions from 1990, 2000, and 2005, and projected emissions out to 2025. The Center for Climate Strategies (CCS) completed the analysis and prepared an initial report in July 2007. Additionally, the Department of Environmental Conservation (DEC) examined GHG emissions from stationary sources operating under Title V operating permits in a report issued January 2008. The final version of the CCS report was completed in July 2009 and included two appendixes from DEC documenting additional analysis of emissions from stationary sources and aviation.

This new report updates the Alaska State Greenhouse Gas Emissions Inventory with results from 1990 through 2010 providing statewide emissions as well as emissions from the stationary sources required to report under the federal Greenhouse Gas Reporting Rule. Stationary sources are typically larger industrial facilities operating in the state and are subject to air quality permit requirements. This new report does not update projections to future years.

The report addresses the six Kyoto greenhouse gases, see Exhibit 2. Exhibit 2 also includes the global warming potential (GWP) of the gases. Throughout this report greenhouse gas emissions are presented using a common metric, carbon dioxide equivalents (CO_2e), which incorporates the relative contribution of each gas to the global average radiative forcing on a global warming potential- (GWP-) weighted basis. The GWP compares the atmospheric warming ability of a compound to carbon dioxide. This comparison means that 1 pound of methane warms the atmosphere as much as 21 pounds of carbon dioxide.

Exhibit 2 – Kyoto Greenhouse Gases

Greenhouse Gas	Common Sources and Uses	Global Warming Potential
Carbon dioxide (CO_2)	Combustion	1
Methane (CH_4)	Combustion, decomposition	21
Nitrous oxide (N_2O)	Combustion	310
Sulfur hexafluoride (SF_6)	Electrical insulator	23,900
Hydrofluorocarbons (HFCs)	Refrigerants	12-11,700
Perfluorocarbons (PFCs)	Semiconductors, medical uses	6,500-9,200

Relationship to Previous Inventory

This new greenhouse gas emissions inventory report supersedes the previous, July 2009, inventory report. Since the preparation of the 2009 inventory report, the Environmental Protection Agency (EPA) has updated emission factors and activity data in the tool used to develop greenhouse gas emission inventories for states. These updates include changes to

data and emission factors for all years from 1990 to 2010, which means that this report includes new results for the years covered by the 2009 inventory. Therefore, values in the two reports should not be directly compared. Some of the differences between the reports may appear as large percentage changes, but are actually small quantity changes. Nonetheless, the results of both inventories show a similar overall picture, that is, both inventories show the same industries as being the highest emitters, and the same overall trends across the years.

Purpose of Stationary Sources Inventory

In addition to the statewide emissions analysis, this report provides an analysis of the GHG emissions Alaskan facilities reported to EPA under the Greenhouse Gas Reporting Rule. This analysis of the stationary sources provides additional insight into major emitters in the state.

Title V Analysis

When the state's first GHG emissions inventory was prepared, some members of the public expressed an interest in gaining a better understanding of the oil and gas industry's emissions. To provide more information on the emissions from industrial activities, DEC analyzed fuel use data from the Title V permit program. These results were incorporated into the July 2009 inventory report.

Federal Greenhouse Gas Reporting Rule

In 2010, EPA implemented the federal Greenhouse Gas Reporting Rule (GHGRR). This rule requires facilities emitting more than 25,000 metric tons (MT) of carbon dioxide equivalents (CO_2e) to report their emissions to the EPA annually. Summaries of the information reported are available to the public via the EPA website.[2]

Using the EPA data provides several advantages for the state when evaluating emissions from large facilities:

- Consistency – Facilities required to report under the federal Greenhouse Gas Reporting Rule report emissions according to protocols that EPA established. This requirement ensures that reporting is consistent from year to year and that all facilities are reporting emissions in the same way.
- Comprehensiveness – Because the EPA Greenhouse Gas Reporting Tool is set up to record greenhouse gas emissions, all relevant data is collected. The state's Title V fuel reporting requirements, however, are in place to address non-greenhouse gas pollutant limitations, and the fuel quantities may not include all the greenhouse gas emissions from a facility.
- Frequency – Under the federal GHGRR, emitters are required to report emissions every year, whereas the facilities reporting fuel use under the Title V program report only every three years.

[2] http://ghgdata.epa.gov/ghgp/main.do, accessed 8/28/13.

- Automation – Because EPA uses a web-based system to collect and report greenhouse gas emissions data, much of the analysis is automated.

For these reasons, in lieu of analyzing Title V data, this report includes a summary of the emissions reported to EPA.

Sector Descriptions

This inventory reports emissions according to eight sectors:

- **Electricity** production includes the emission from fuels combusted to produce electricity provided to the grid. The grid may be the railbelt grid or a small local grid providing electricity to one community. Examples include the Healy Power Plant, and diesel generation in rural communities.
- **Residential and Commercial** emissions come from combustion at homes and commercial buildings, mostly from heat. For example, home and hot water heating or building heat in office buildings.
- **Industrial** emissions come from the fuel burned by industry as well as the fugitive emissions that come from the oil and gas industry. This sector includes emissions from all the natural gas burned by the oil and gas industry, as well as the fuel burned in other industries. Fugitive methane emissions from the oil and natural gas industries are also included in this category.
- **Transportation** sector includes emission67s from cars, boats, plans, trains, and other mobile equipment.
- **Industrial Processes** are processes that produce greenhouse gas emissions as a result of the chemical reaction taking place or a fugitive emission that occurs in an industrial process. For example, the process of making cement releases carbon dioxide. Other gases reported in this section, HFCs, PFCs, and SF6, are primarily released as fugitive emissions.
- **Waste** decomposition can give off methane, such as when waste food decomposes anaerobically.
- **Agriculture** produces greenhouse gases via several mechanisms; examples include excess fertilizer can converting to nitrous oxide and decomposition in the producing methane.
- **Emission Sinks** represent the carbon dioxide taken up by plants minus the methane and nitrous oxide emissions that result from wildfire.

Projections

Unlike the initial inventory, this inventory does not include projections of expected future emissions. For a number of sectors, the projections for 2010 in the initial inventory turned out to be grossly inaccurate. The 2008 economic downturn and subsequent slow recovery

is likely a key driver in some overestimates. The projections for 2010 also predicted an increase in emissions from the natural gas industry that was not realized.

Emission inventory projections rely on several factors being accurate: the initial inventory, having correctly identified the drivers changing the activity, and good estimates of changes in the emitting activity. In addition, projections are most useful for evaluating mitigation strategies. For such work, multiple "what if" scenarios may be of the most benefit. This inventory update effort did not include updates to future emissions as there were no specific scenarios identified. Thus, there was little benefit to be gained from the work of preparing projections.

Methodology

EPA provides the State Inventory Tool (SIT) for states to prepare greenhouse gas emission inventories. This tool develops the inventory in a top-down fashion, applying emission factors to statewide activity data (e.g., gallons of fuel used). The tool consists of a set of Excel spreadsheets, referred to as modules, with one spreadsheet for each emission category (see Exhibit 3).

The SIT spreadsheets come with the formulas, emission factors, conversion factors, and global warming potentials embedded in them. EPA has also built into the modules relevant state-level default data from a variety of federal agencies. The user may choose to use the default data or to supply data from other sources. The tool calculates emissions across all sectors for all six Kyoto greenhouse gases.

This inventory is based on the 2013 version of the EPA State Inventory Tool (SIT). Additional data developed by the state supplemented the defaults in the tool. See Appendix A for additional information on the data sources. For comparison, the July 2009 inventory generally used the 2006 version of the SIT along with some additional data sources.

Adjustments to State Inventory Tool

To better account for fuel uses in Alaska, DEC adjusted the transportation, residential and commercial heat, and electric generation emissions from diesel fuel instead of using the default values in the SIT. DEC also assumed a 10% lower fuel economy for Alaskan vehicles than the national averages included in the tool, which affected both diesel and gasoline emission from on-road vehicles. The vehicle mix in Alaska includes more large vehicles than the national average. These larger vehicles, with lower fuel economy, shift the state average lower than the national average.

Exhibit 3 – SIT Modules

Module	Description	Gases
Agriculture	Emissions from agricultural activities	CH_4, N_2O
Fossil Fuel Combustion	Emissions from the combustion of fossil fuels – includes fuels combusted across all sectors. Other gases produced are addressed by sector	CO_2
Coal	Emissions from coal mining and abandoned coalmines	CH_4
Electricity Consumption	Electricity emissions are based on electricity consumed in state[3]	CH_4, N_2O
Industrial Processes	Emissions from industrial processes	all gases
Land Use, Land Use Change, Forestry	Emissions from forestry practices include the effects of changes in land uses on carbon sinks	CH_4, N_2O, CO_2
Mobile Combustion	Non-CO_2 emissions from mobile sources	CH_4, N_2O
Natural Gas and Oil	Emissions from production and transmission of natural gas and oil	CH_4, N_2O
Solid Waste	Emissions from solid waste disposal	CH_4, N_2O, CO_2
Stationary Combustion	Non-CO_2 emissions from stationary combustion	CH_4, N_2O
Wastewater	Emissions from wastewater and treatment	CH_4, N_2O

The SIT calculates CO_2 from transportation sources in two ways:

1. Total CO_2 emissions based on the total quantity of transportation fuel sold within the state
2. Emissions by mode
    - Marine, aviation, and rail are still based on fuel sales data
    - On-road vehicle fuel use is calculated for ten different vehicle and fuel combinations based on vehicle miles traveled and fuel economy

These two calculations produce results that differ by several million metric tons. That is, when all the individual modes from the second method are added together, the sum is less than the total emissions calculated based on diesel fuel sold as transportation fuel. The discrepancy in total transportation emissions is larger for Alaska than the other states.[4]

As part of another effort, DEC developed inputs representing 2011 for EPA's Motor Vehicle Emissions Simulator (MOVES). This model estimates emissions for on-road vehicles like

[3] For some states, distinguishing between the electricity consumed in state from the electricity produced in state is important. Because Alaska does not import or export electricity, this distinction is not important and results represent in-state electricity production.

[4] Personal communication with Philip Groth, ICF, August 12, 2013.

cars and trucks. Using these inputs, DEC estimated that on-road vehicles generated 2.79 MMT CO_2e in 2011.[5] The MOVES estimates confirm the validity of the approach to adjust the on-road emissions approach in the SIT. For 2010, the SIT estimates on-road emissions to be 2.57 MMT CO_2e. The adjusted value for the same year is 2.81, much closer to the MOVES-derived value.

Rural Fuel Use

The State of Alaska offers rural communities the opportunity to reduce the price of electricity to their customers through the Power Cost Equalization (PCE) program. Every year participating communities report their total fuel use to the program. The emissions from these reported fuel quantities are greater than the total emissions the SIT calculated for all electric generation from diesel for the entire state.

The fuel data in the SIT comes from Department of Energy (DOE), which develops the data based on surveys completed at the distributor level. Based on these discrepancies, DEC assumed that all the diesel fuel going to rural Alaska is labeled as transportation fuel, but some is diverted for other uses, primarily electric generation and home and business heating.

DOE estimates that 8%[6] of all energy in Alaska is used in homes and that 36%[7] of all Alaskan homes use fuel oil for heat. Applying these percentages to the total energy use in the state suggests a higher estimate of the diesel use in the residential and commercial sector than the SIT tool provides.

To better account for the actual uses of fuel in rural Alaska, DEC adjusted the results of the SIT according to the following descriptions.

Electric generation adjustments

We assumed the distillate fuel for electric generation provided in the SIT covered only the railbelt grid. Alaska Energy Authority provided total fuel for the PCE program and the number of residents in participating communities. From this information, we calculated average diesel use per person for electric generation. DEC used this value to calculate total diesel use for electric generation in rural Alaska. The total of the PCE and non-PCE communities was added to the electric generation sector and subtracted from the transportation sector.

Home heating adjustments

Similar to the electric generation modifications, adjustments for home heating were added to the residential category and subtracted from the transportation sector.

[5] Inputs were prepared to comply with the EPA 2011 National Emissions Inventory submission requirements.
[6] http://apps1.eere.energy.gov/states/consumption.cfm/state=AK
[7] http://apps1.eere.energy.gov/states/consumption.cfm/state=AK

The energy information provided in the tool is sufficient to calculate the total energy use per person in the state. Information from the DOE shows that in Alaska 8% of energy is used for home heating, and 36% of Alaskan homes use fuel oil (diesel) for heat. The difference between the amount calculated in this manner and the values provided in the SIT were subtracted from the transportation total and added to the residential and commercial total.

Results

Exhibit 4 presents the gross emissions for the state for all years graphically by sector. Exhibit 5 lists the greenhouse gas emission in Alaska for selected years and includes emission sinks, as well. Numerical results for all sectors and all years are in Appendix B.

The industrial sector, including fuels used in industry as well as emission from the oil, natural gas, and coal industries, contributes the most to Alaska's greenhouse gas emissions, with the transportation sector providing the second most. The residential and commercial sector and electric production are the third and fourth largest emission generators. Industrial processes, agriculture, and waste all contribute minimally to the state's greenhouse gas emissions. Industrial process emissions come from chemical reactions that produce greenhouse gas emissions; for example, cement production directly releases carbon dioxide.

Exhibit 6 breaks out the emissions by sectors for the years 1990, 2000, 2005, and 2010, respectively. Only those sectors with sections visible in the charts are labeled.

Exhibit 4 – Gross Annual Greenhouse Gas Emissions from 1990 to 2010

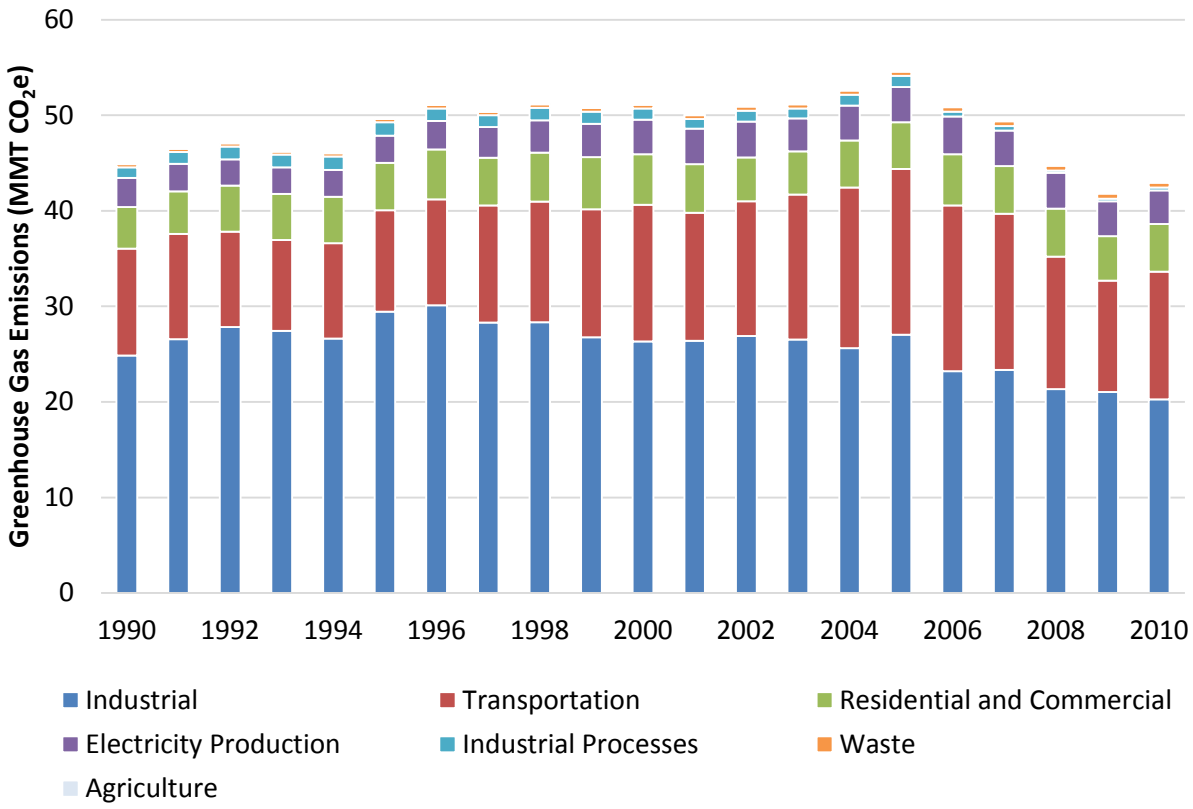
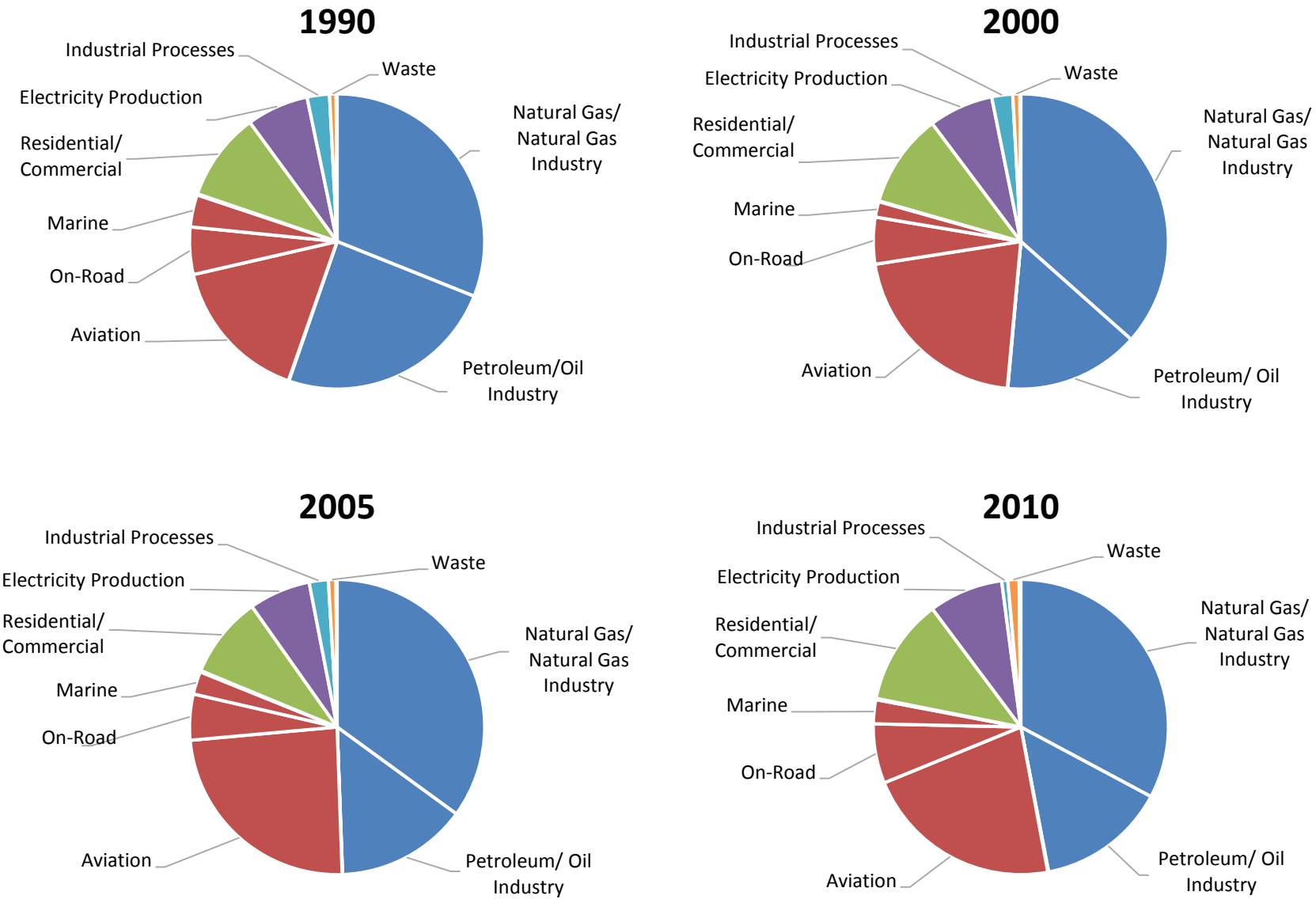


Exhibit 5 – Alaska's Greenhouse Gas Emissions (MMT CO_2e)

	1990	2000	2005	2006	2007	2008	2009	2010
Electricity Production	**3.05**	**3.62**	**3.69**	**3.96**	**3.74**	**3.73**	**3.65**	**3.51**
Coal	0.45	0.78	0.57	0.58	0.58	0.58	0.59	0.56
Natural Gas	1.87	1.89	2.10	2.31	2.19	2.31	2.03	2.12
Petroleum	0.73	0.95	1.02	1.07	0.96	0.84	1.02	0.83
Residential & Commercial	**4.36**	**5.27**	**4.90**	**5.35**	**4.97**	**5.03**	**4.68**	**5.02**
Coal	0.77	0.80	0.77	0.86	0.73	0.84	0.80	0.84
Natural Gas	1.80	2.32	1.86	2.09	2.06	2.06	1.95	1.85
Petroleum	1.78	2.14	2.24	2.38	2.16	2.11	1.91	2.30
Wood (CH_4 and N_2O)	0.012	0.013	0.019	0.019	0.020	0.020	0.021	0.022
Industrial	**24.87**	**26.33**	**27.02**	**23.21**	**23.36**	**21.33**	**21.04**	**20.26**
Coal/Coal Mining	0.026	0.026	0.024	0.025	0.023	0.022	0.034	0.038
Natural Gas/ NG Industry	13.95	18.70	19.13	15.70	15.69	14.28	14.43	14.12
Petroleum/Oil Industry	10.90	7.60	7.86	7.49	7.65	7.02	6.57	6.10
Transportation	**11.18**	**14.31**	**17.37**	**17.37**	**16.35**	**13.89**	**11.64**	**13.36**
Aviation	7.21	10.78	13.18	13.09	11.98	9.82	7.75	9.37
Marine	1.59	0.87	1.36	1.48	1.46	1.24	0.98	1.13
On-Road	2.33	2.62	2.75	2.73	2.84	2.77	2.85	2.81
Rail and Other	0.059	0.043	0.082	0.078	0.067	0.058	0.056	0.060
Industrial Processes	**1.10**	**1.17**	**1.14**	**0.48**	**0.47**	**0.26**	**0.27**	**0.29**
Ammonia Production	1.050	0.966	0.885	0.216	0.214	0.000	0.000	0.000
Urea Production	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Limestone & Dolomite Use	0.000	0.010	0.007	0.006	0.000	0.000	0.000	0.000
Cement Manufacture	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ODS Substitutes (HFC, PFC)	0.001	0.169	0.224	0.231	0.232	0.234	0.242	0.264
Soda Ash (CO_2)	0.006	0.006	0.006	0.006	0.006	0.005	0.005	0.005
Electric Power T&D[8]	0.042	0.023	0.023	0.022	0.020	0.021	0.021	0.020
Waste	**0.32**	**0.40**	**0.45**	**0.47**	**0.49**	**0.50**	**0.52**	**0.53**
Solid Waste Management	0.27	0.34	0.39	0.40	0.42	0.44	0.45	0.46
Wastewater Management	0.052	0.060	0.065	0.066	0.066	0.067	0.068	0.069
Agriculture	**0.05**	**0.05**	**0.07**	**0.07**	**0.08**	**0.08**	**0.09**	**0.08**
Agricultural Soils	0.030	0.026	0.031	0.034	0.038	0.037	0.040	0.033
Enteric Fermentation	0.015	0.019	0.026	0.028	0.029	0.026	0.025	0.025
Manure Management	0.001	0.007	0.009	0.008	0.008	0.014	0.021	0.021
Gross Emissions	**44.93**	**51.16**	**54.64**	**50.92**	**49.45**	**44.81**	**41.88**	**43.04**
Emission Sinks	-6.50	-25.20	5.20	-29.04	-26.06	-30.31	-8.15	-22.37
Net Emissions	**38.43**	**25.96**	**59.84**	**21.87**	**23.39**	**14.50**	**33.74**	**20.67**
Increase Over 1990	0.00	6.23	9.71	5.99	4.52	-0.12	-3.05	-1.89
Increase Relative to 1990	0%	14%	22%	13%	10%	0%	-7%	-4%

[8] T&D = Transmission and distribution.

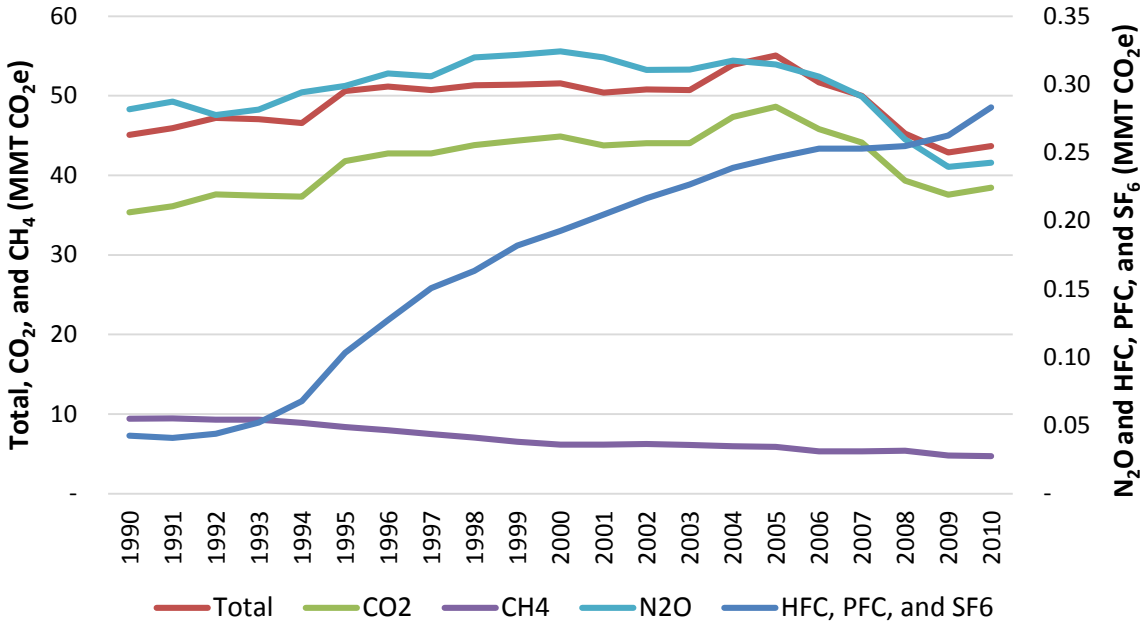
Exhibit 6 – Emissions Distributions



Emissions by Gas

This report examines the greenhouse gas emission in Alaska for the six "Kyoto gases." Exhibit 7 shows the state's emissions trends by gas for the last twenty years. This graph includes the trend for the total emissions (red line) as a comparison. The emissions trend for carbon dioxide closely mirrors the overall emissions trend. Nitrous oxide also follows the trend relatively well. Methane emissions have steadily decreased over the last twenty years, whereas emissions from HFCs, PFCs, and sulfur hexafluoride have increased. For the purpose of this inventory, HFC and PFC emissions are calculated on a per capita basis, and thus track with national trends. These emissions have increased because of our increased use of electronics and Alaska's trends track with national trends.

Exhibit 7 – Emission Trends by Gas



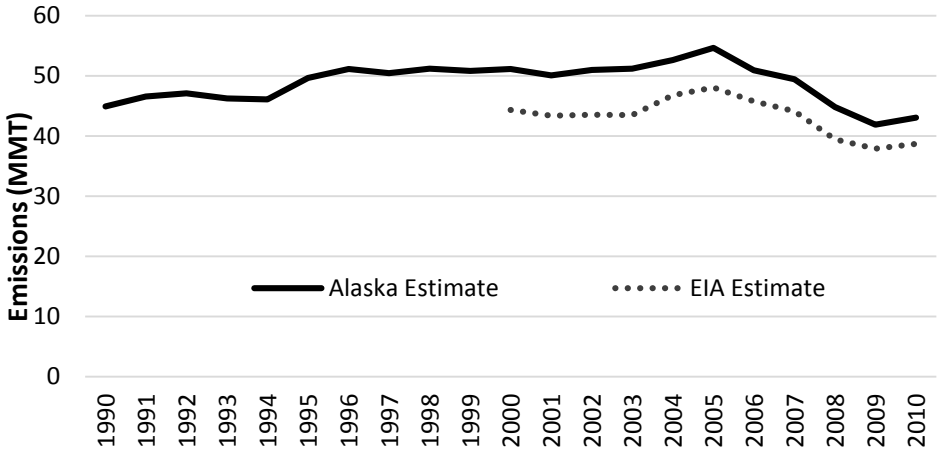
Alaska in Perspective

The Energy Information Administration (EIA) calculates energy-related carbon dioxide emission for all states each year.[9] These estimates exclude emissions of other greenhouse gases and all non-energy sources. Although EIA's estimates do not include all greenhouse gases, a large portion of the country's greenhouse gas emissions come from burning fuels for energy. Exhibit 8 compares the Alaska state inventory total from 1990 through 2010 with the totals provided by the EIA from 2000 through 2010. As expected, the EIA values are lower, but do follow a similar trend as the Alaska inventory.

Exhibit 10 compares Alaska's total emissions to those of other states. According to EIA, in 2010, 11 states had smaller emissions totals than Alaska.

[9] http://www.eia.gov/environment/emissions/state/analysis/. Accessed 1/10/2014.

Exhibit 8 – Total Emissions Alaska and EIA



Per Capita Emissions

Comparing per capita emissions offers another perspective on the state's emissions. This view considers the states' emission in relation to their population. Exhibit 9 shows the per capita emission trend in Alaska, as well as the per capita trend of the estimate from the EIA. Again, the EIA values are lower, but follow the same trend as the Alaska inventory.

On a per capita basis, in 2010 Alaska has the third highest emissions, behind Wyoming and North Dakota. All three states have relatively small populations and strong oil and gas industries. Exhibit 11 compares Alaska's per capita emissions with those of other states. Exhibit 12 compares per capita emissions minus industrial emissions by state.

Exhibit 9 – Per Capita Emission Trends

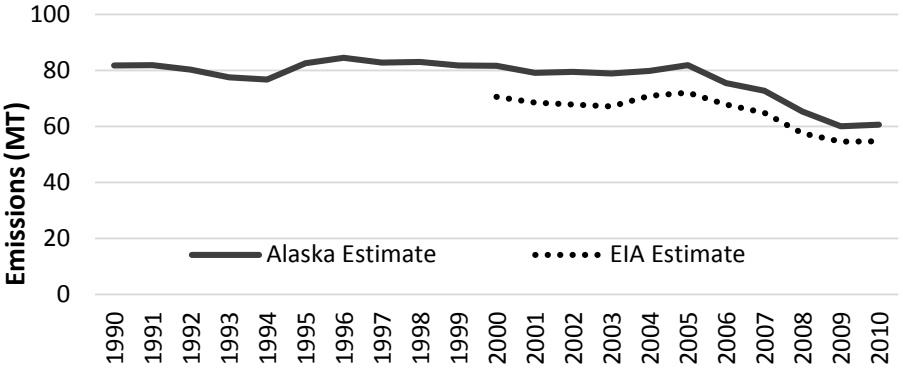


Exhibit 10 – Total Emissions for All States

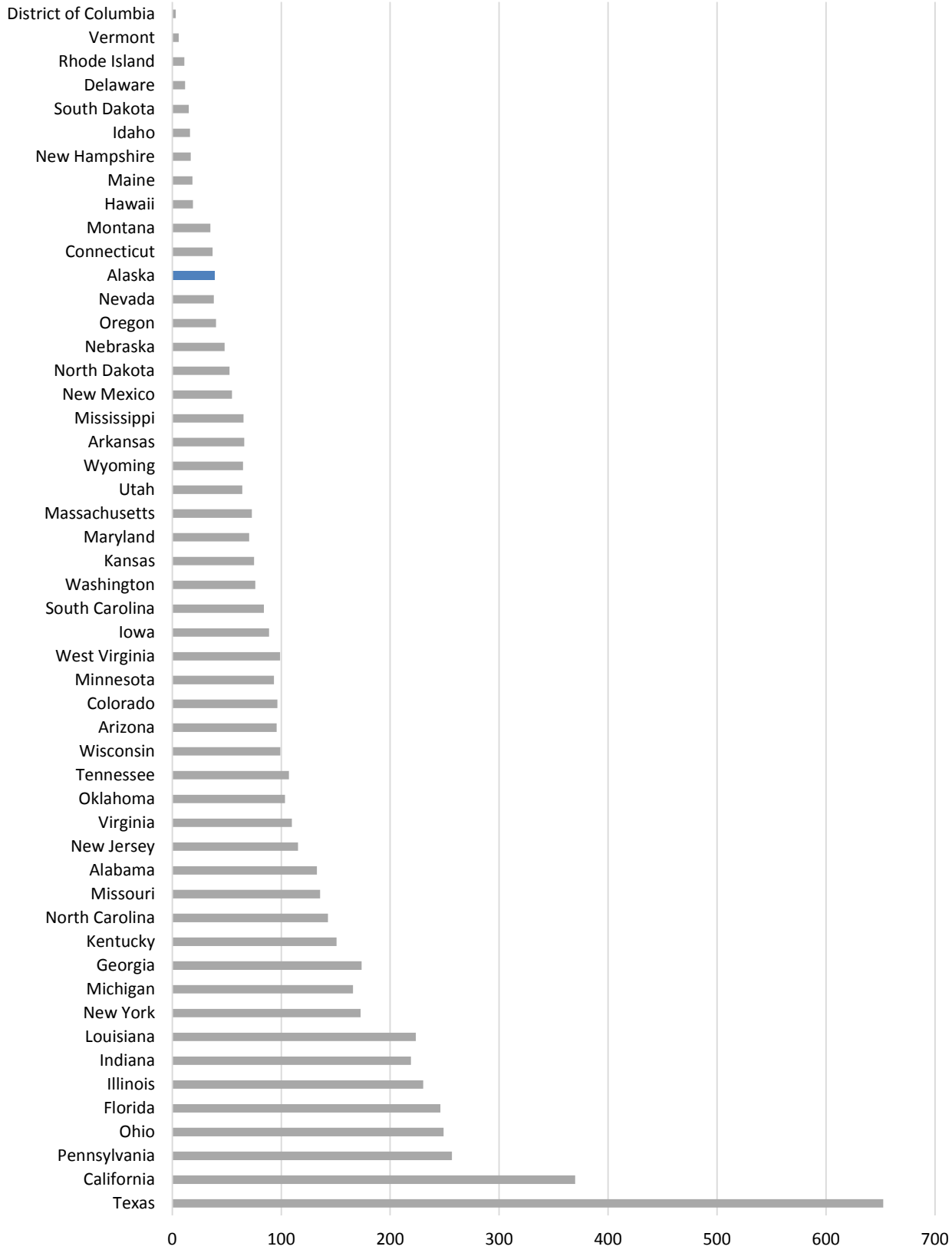


Exhibit 11 – Per Capita Emissions for All States

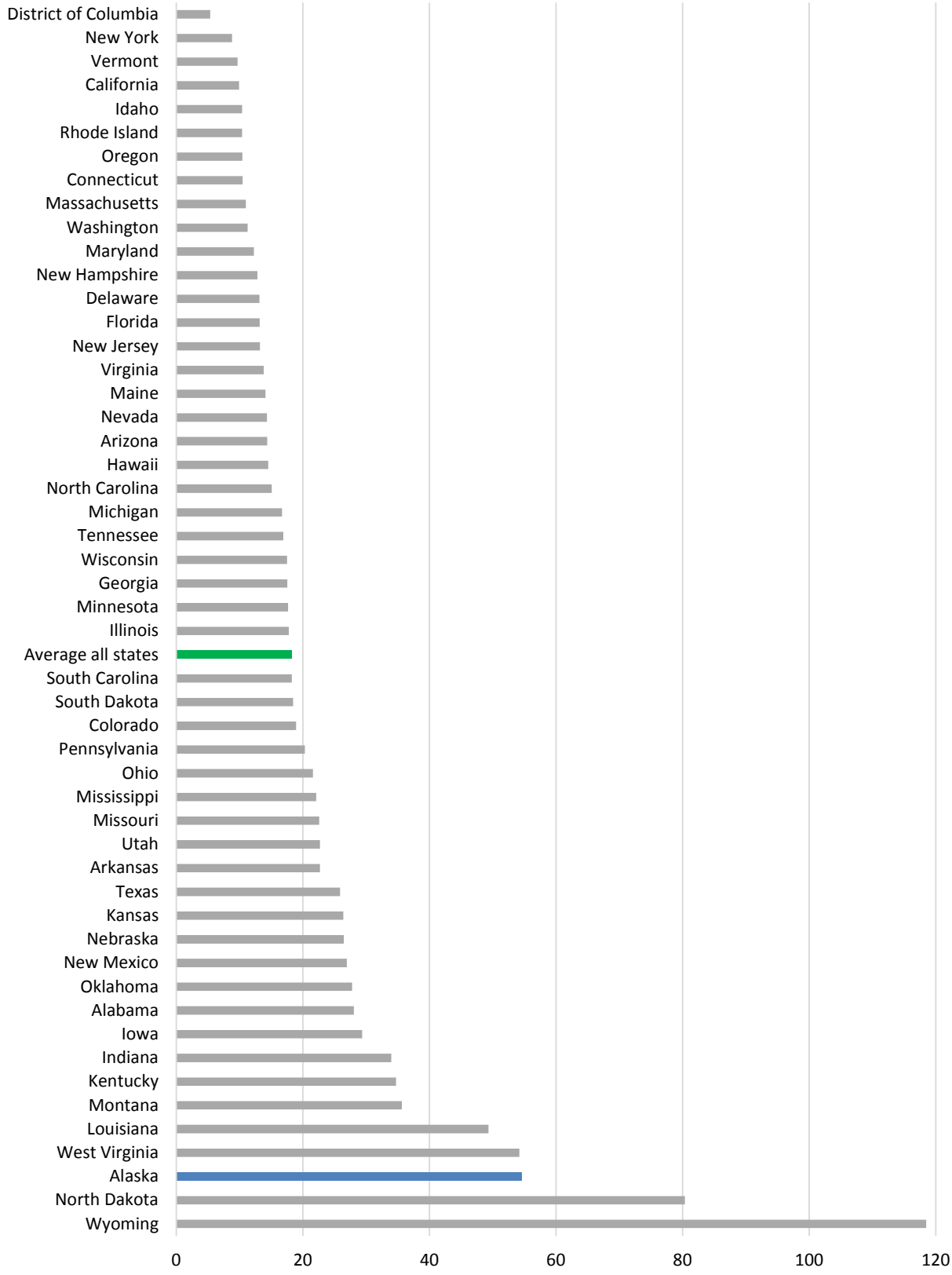
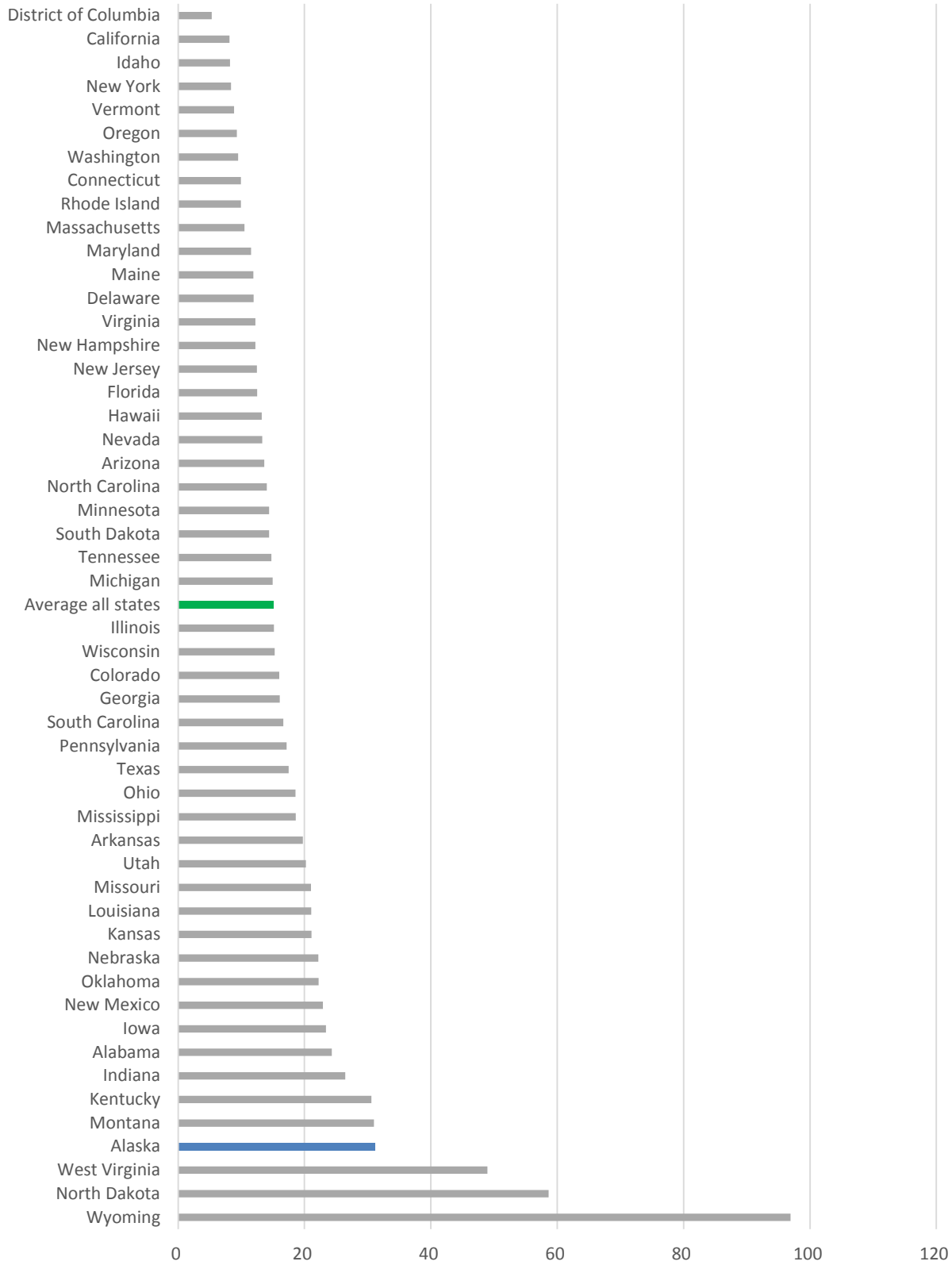


Exhibit 12 – Per Capita Emissions without Industrial Emissions – All States

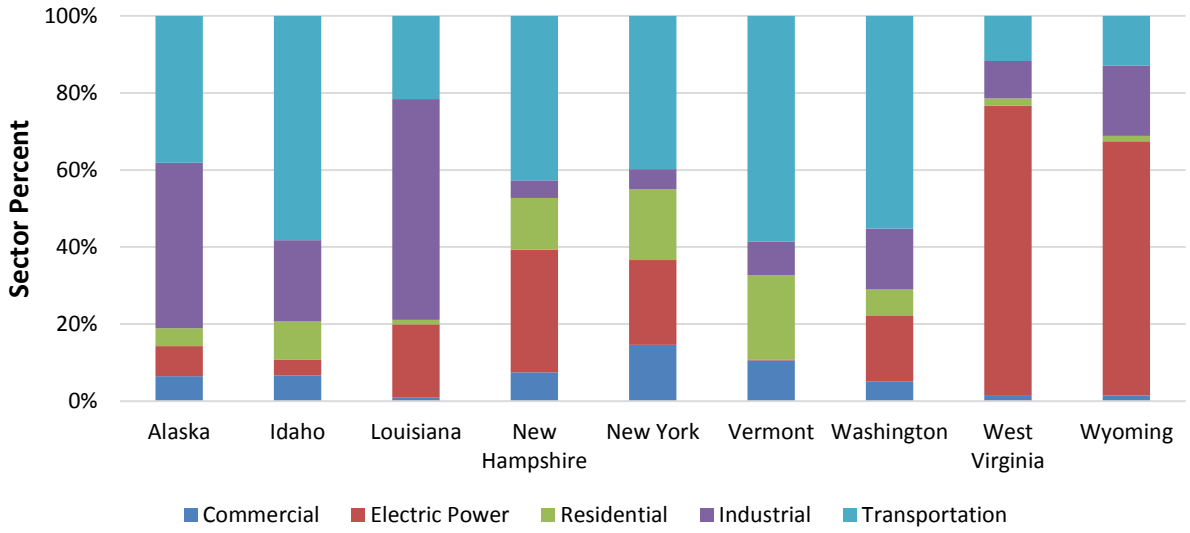


Sector Emissions

In addition to emission totals and per capita emissions varying from state to state, EIA also provides data on the source make up of each state's emissions. Exhibit 13 compares Alaska's source make up to that of several other states. About 40 percent of Alaska's energy related carbon dioxide emissions come from the transportation sector and another 40 percent from industry. Some states, such as West Virginia and Wyoming, have a large electric production sector that emits a significant portion of their emissions. Compared to Alaska, energy emissions in Idaho and Vermont are more driven by the transportation sector. In Louisiana, industry produces the greatest portion of emissions.

With the major contributors to greenhouse gases varying greatly from state to state, when considering strategies to reduce greenhouse gas emissions, there is no one set of policies or programs that will work across the board. Each state must identify the strategies to address their unique mix of sources and other state characteristics.

Exhibit 13 – Energy-Related CO_2 Emissions Distributions by Sector, Selected States [10]



Alaskan Sector Results

Industrial Emissions

The industrial sector includes the fuel consumed by all industrial operations as well fugitive methane emissions from the oil, natural gas, and coal extraction industries.[11]

In 2010, the industrial sector produced almost half of the state's greenhouse gas emissions. Fugitive methane contributed a little over 20% of the CO_2e emitted by this sector. Most of

[10] Based on Energy Information Administration data that only includes CO_2 emissions from energy production.

[11] Emissions released through chemical reactions and releases of HFCs, PFCs, and SF_6 are calculated in the industrial processes sector.

this fugitive methane comes from oil production, a small portion comes from natural gas production.

The tool calculates fugitive emissions from the oil and gas sector based on a national average quantity of fugitive emissions per barrel of oil produced. The extent to which this average reflects Alaska's fugitive emissions is unknown. Information gathered by the Climate Change Sub-Cabinet during 2007 and 2008 indicates that Alaska's fugitive emissions are likely less than the national average used in the tool. Because of the harsh environment in which Alaskan oil and gas operations take place, some equipment that would be outdoors in other areas is housed in buildings in Alaska. In order to prevent the buildup of flammable gases in the confined space of a building, this equipment must be tightly sealed against fugitive emissions.

Exhibit 14 shows that in 2010 natural gas produced almost about 70 percent of this sector's emissions. The next exhibit, 15, shows that carbon dioxide emissions make up about 80 percent of the emissions from this sector. Together these results show that it is largely the combustion of natural gas in industrial applications that drives this sector, not necessarily the production of natural gas. Stated another way, because natural gas is the primary fuel source for many industrial facilities, it is also the most common source of greenhouse gas emissions for this sector.

Exhibit 14 – Industrial Sector Emissions

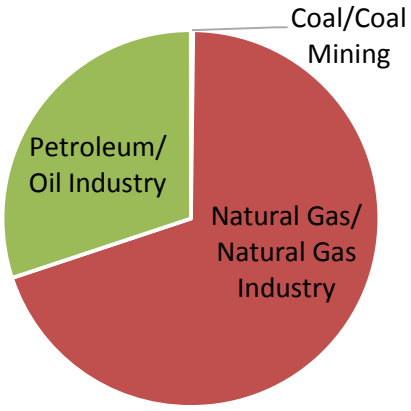


Exhibit 15 – Industrial Sector Emissions by Greenhouse Gas

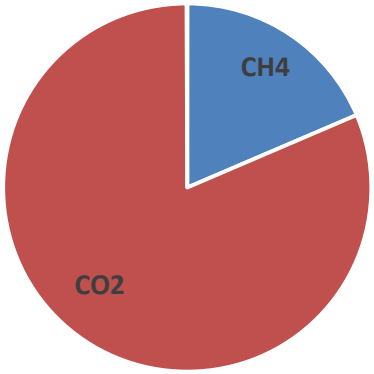


Exhibit 16 show the quantities of carbon dioxide equivalents produced by combustion and from fugitive emissions.

Exhibit 17 displays the emission trends of natural gas, petroleum, and coal from 1990 through 2010. The fugitive emissions for the oil and gas industries are calculated based on the quantity of oil and natural gas produced. Thus, the decline in the state's oil production is one factor contributing to diminishing emissions in this sector. Coal emissions contribute minimally to this sector.

Exhibit 16 – Industrial Sector Emission by Fuel and Emission Type

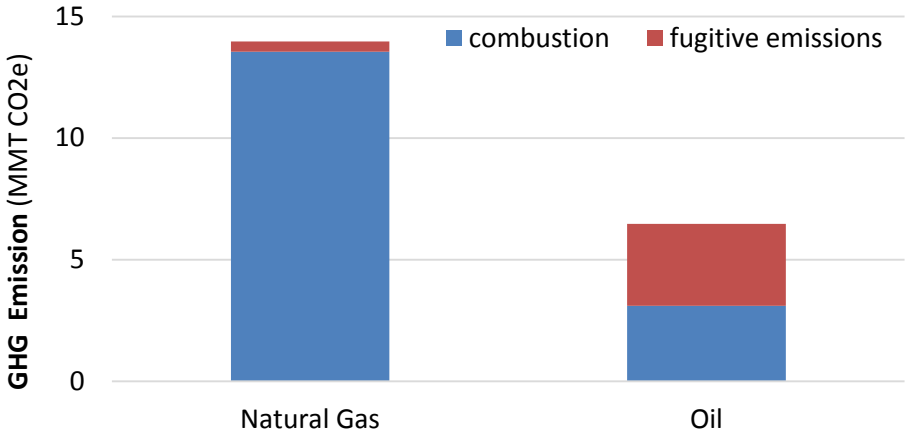
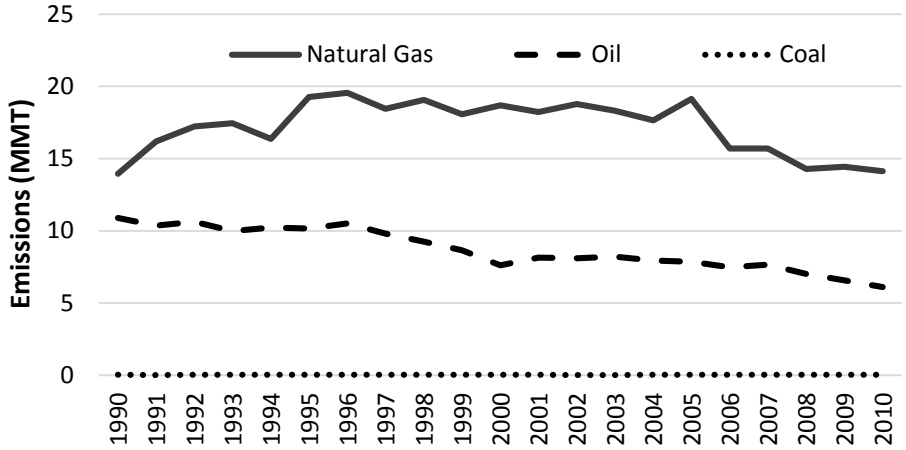


Exhibit 17 – Industrial Emission Trends



Industrial Processes

In addition to the fuel used in industrial operations, some industrial processes release greenhouse gases from the chemical processes taking place, e.g., cement production releases carbon dioxide. Other industrial applications require compounds with very high global warming potentials, such as hydrofluorocarbons or perfluorocarbons. Even under the best conditions, small quantities of these materials leak into the atmosphere. The industrial processes sector also captures the sulfur hexafluoride used as an insulator in electricity transmission and distribution. Sulfur hexafluoride is a powerful greenhouse gas contributor, about 23,900 times stronger than carbon dioxide.

Exhibit 18 demonstrates that the sources of Alaska's industrial process emissions have shifted over the last 20 years. Exhibit 19 shows the trend from 1990 to 2010. The drop in emissions between 2005 and 2006 reflect the Agrium plant closing and the associated reduction in urea and ammonia production. The Agrium plant closing is also evident in Exhibit 18. In 1990, emissions from industrial processes were primarily from ammonia production. By 2010, HFCs, PFCs, and SF_6 had become the dominant source within this sector.

Overall, industrial processes contributed a very small portion of the state's greenhouse gas emissions in 2010, about one percent.

Exhibit 18 – Industrial Process Emissions, 1990 and 2010[12]

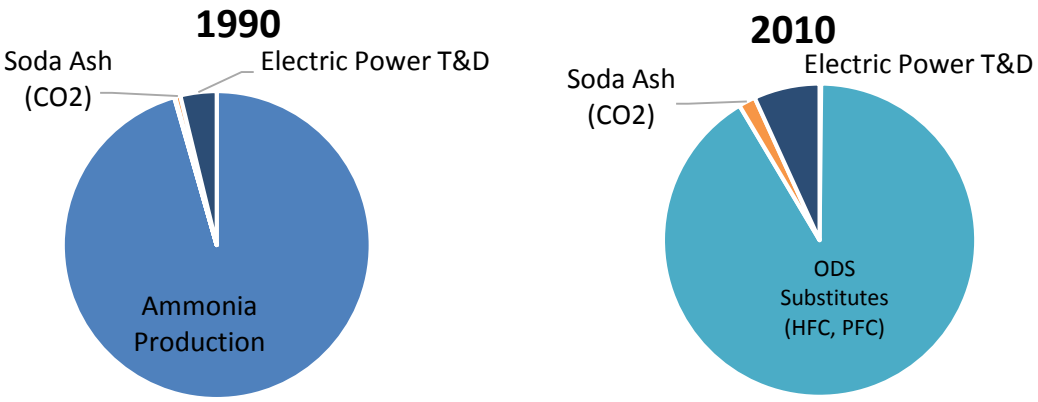
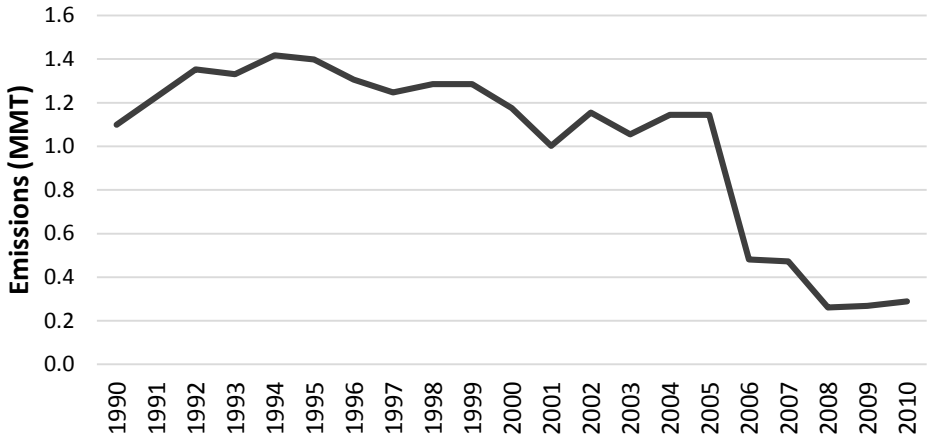


Exhibit 19 – Industrial Process Emissions



Transportation

Transportation emissions are generated from burning fuel in cars, trucks, snow machines, boats, aircraft, construction equipment, and other mobile equipment. The carbon dioxide emissions are directly proportional to the quantity of fuel consumed, but the methane and nitrous oxide emissions depend on the type of equipment. In all segments of the transportation sector, fuel use is the driving factor determining the greenhouse gas emissions. Fuel use is, in turn, related to the distance traveled and vehicle efficiency, as well as the number of vehicles operating.

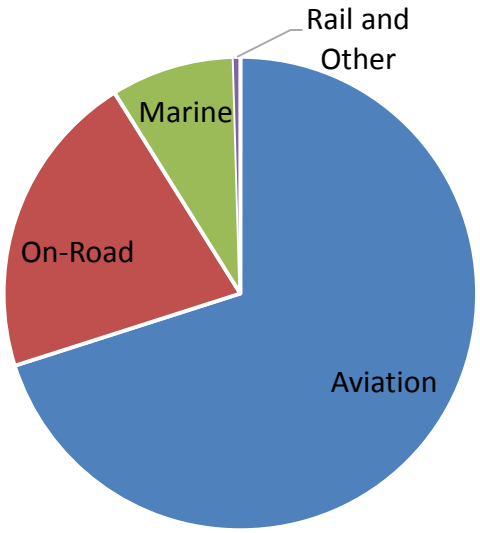
In 2010, transportation contributed almost one-third of the state's greenhouse gas emissions. As Exhibit 20 shows, about two-thirds of the transportation emissions are from the aviation sector. It is difficult to parse out the portion of these emissions that are taking place in Alaskan airspace because the inventory is based on fuel sales. All fuel sold in Alaska is accounted for in the state's inventory although not all of the fuel is used within the state's boundaries. Anchorage is a refueling stop for many overseas air cargo flights; and

[12] ODS = ozone depleting substitutes, T&D = transmission and distribution

aviation emissions in Alaska are significantly affected by the number of aircraft refueled here during transcontinental trips.

As part of the initial inventory, DEC supplemented the CCS inventory with additional work on aviation emissions, which was documented in Appendix B of that inventory. The work was cursory, but does provide a useful estimate of the portion of the emissions contributed by international flights refueling in Alaska. According to this previous analysis, commercial aviation produces about 96 percent of the aviation emissions, with general aviation and military aircraft each contributing about 2 percent, see Exhibit 21. This analysis also estimated the international commercial emissions for 2005 to be 7.65 MMT CO_2e.

Exhibit 20 – 2010 Transportation Emissions



For on-road vehicles, over the last two decades, the annual average vehicle miles traveled per person in the state has varied from about 6,500 to about 7,600. As state population has grown, the total miles driven in the state has grown.

Exhibit 22 depicts the transportation sector emission trends for the last two decades. The sharp decline in aviation emissions between 2007 and 2009, about 35%, could be partly related to the recent recession. Changes in transport patterns could also affect the aviation emissions from international air traffic. A similar, although at a much lower level, pattern occurs in marine emissions. On-road emissions have increased steadily over the last two decades. Rail and other transportation sources, such as tractors, make up the smallest portion of this sector.

Exhibit 21 – Aviation Emissions

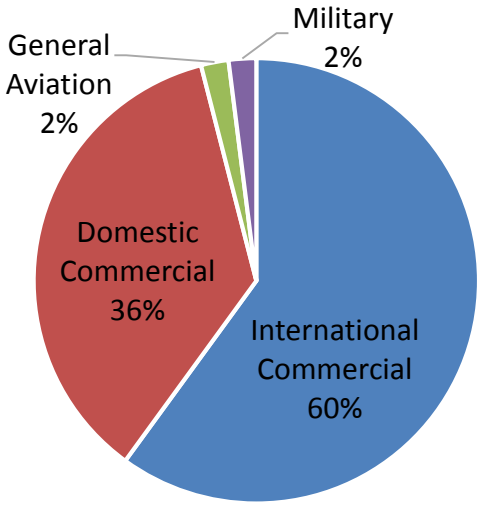
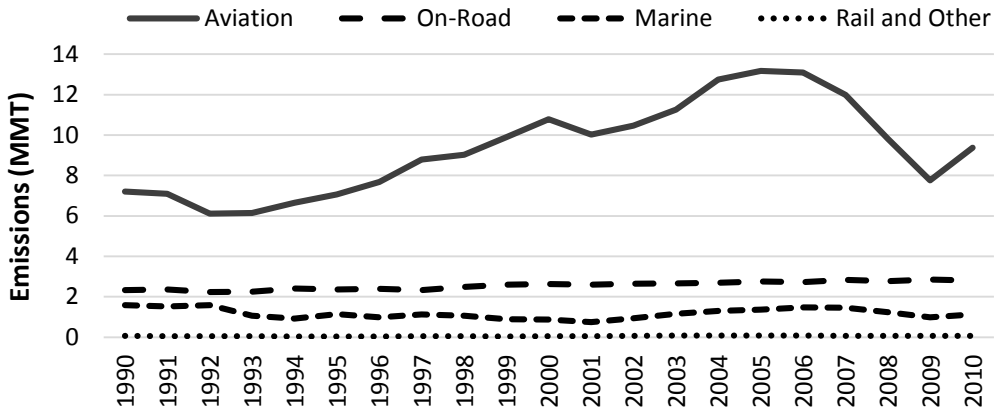


Exhibit 22 – Transportation Emissions

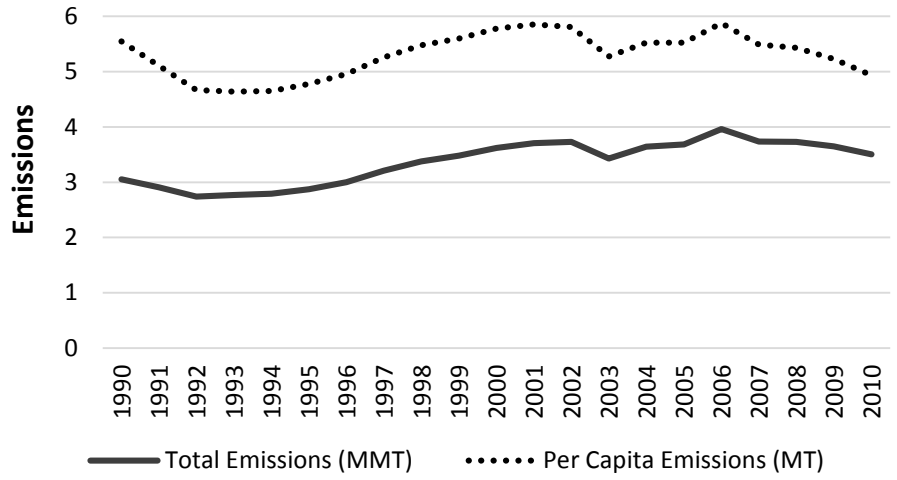


Electricity Production

Emissions from the electricity production sector come from the fuel burned to produce electricity that is delivered to an electric grid serving customers. This sector excludes emissions from electricity produced for industrial use on the North Slope or at other generating facilities not tied to the rail belt grid or expressly serving individual communities. Prudhoe Bay generation is included in the industrial sector. Exhibit 23 shows the trend in electric emissions over time as well as the trend in per capita emissions. Over the last two decades, electric generation has steadily accounted for about 8 percent of the state's greenhouse gas emissions. The trends in total emission and per capita emissions for this sector are strikingly similar. Demand for electricity drives the need for electric generation and the associated emissions.

With recent upgrades to several southcentral Alaska power plants and new renewable generation online, it is expected that future per capita emissions from electricity production will further decline.

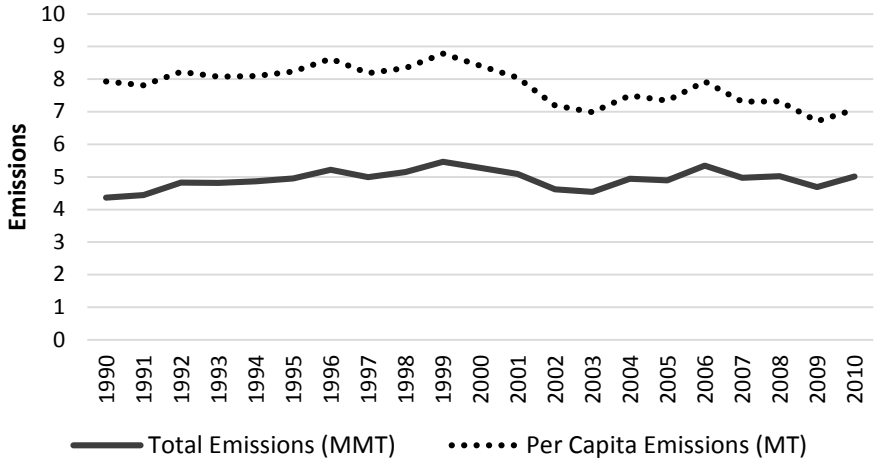
Exhibit 23 – Electricity Production Emissions



Residential and Commercial

Emissions in the residential and commercial sector come from fuel use in stationary sources in homes and businesses, such as home and building heating. Exhibit 24 shows that although there are some ups and downs in this sector's emissions, the trend is roughly flat, indicating that as the population has grown, we have become more efficient in our energy use in these areas through various energy efficiency measures. Our becoming more efficient is also evident in looking at the per capita emissions for this sector. In 2010, the residential and commercial sector contributed about 12 percent of the state's emissions.

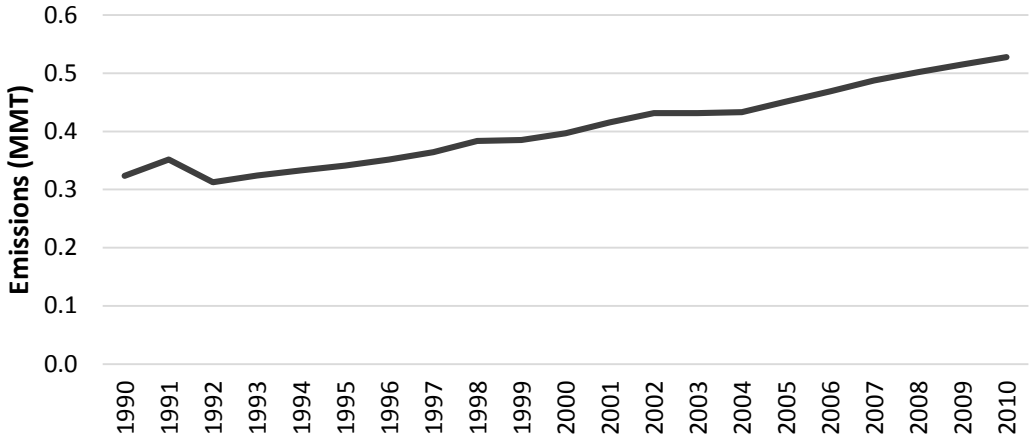
Exhibit 24 – Residential and Commercial Emissions



Solid Waste

Waste disposal also generates greenhouse gas emissions, primarily methane from decomposition. Exhibit 25 displays the trend in Alaska's solid waste greenhouse gas emissions from 1990 to 2010. Producing about one percent of the state's greenhouse gas emissions, the solid waste sector contributes minimally to the states emissions, but the trend is toward increasing emissions.

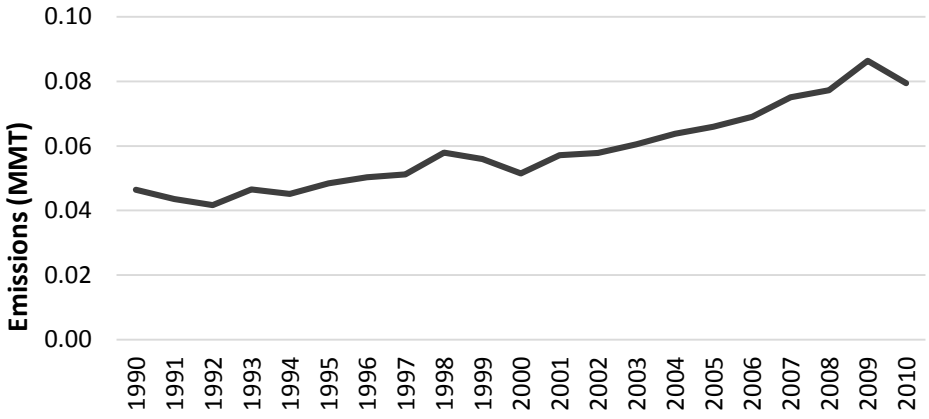
Exhibit 25 – Waste Emissions



Agriculture

Both crops and livestock production generate greenhouse gas emissions through decomposition and similar biological processes. The trend for the last two decades is shown in Exhibit 26. Although agricultural emissions have grown over the past twenty years, they remain a small fraction of the states total emissions, less than 1 percent. Emissions from agricultural equipment burning fuel are captured in the transportation category.

Exhibit 26 – Agriculture Emissions



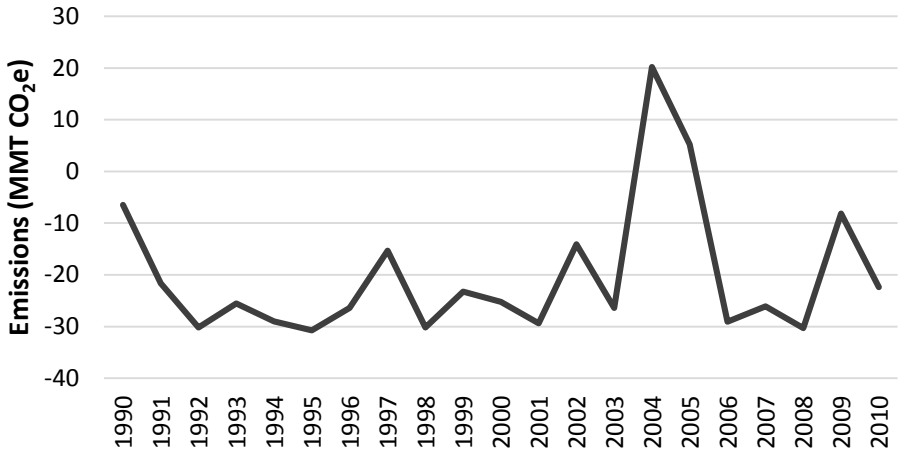
Emission Sinks – Land Use, Land Use Change, and Forestry

The way we use land affects the ability of the natural environment to take up and store, or sequester, carbon, serving as "emission sinks" by removing carbon from the atmosphere. The land use, land use change, and forestry sector calculations take into account a variety of factors that affect the ability of the soil and plants to store carbon. These factors are relatively stable over time, with the exception of wildfires, which can vary greatly from year to year. The carbon dioxide from wildfires is excluded from the emission inventory on the basis that it will be absorbed by other plants as they grow to replace those that burned during the fire. However, in addition to releasing carbon dioxide, wildfires also produce nitrous oxide and methane, which are less readily incorporated into new plant growth. In addition, these two compounds are stronger greenhouse gases than carbon dioxide.

Exhibit 27 shows the net emissions from emission sinks and wildfires. In most years, this sector sequesters carbon from the atmosphere. In years with abundant wildfires, such as 2004 and 2005, however, this sector contributes additional emissions to the atmosphere.

This analysis does not include any consideration of permafrost melting and subsequent methane emissions. The complexity of such an analysis is beyond the scope of this effort.

Exhibit 27 – Emission Sinks



Stationary Sources Inventory

In order to better understand the contributions of large stationary sources, for the initial inventory, DEC calculated emissions from sources with air permits. These calculations supplemented the overall inventory.

The stationary sources inventory uses a "bottom up" approach, starting with fuel use for each facility. The inventory prepared using EPA's SIT uses a "top down" approach, based on overall state fuel uses and other activity data. These inputs are estimated at the state level, not aggregated from individual sources or locations. Each approach has its own utility: bottom up for understanding the contributions of specific facilities, top down for aggregate emissions from all sources where collecting individual activity data would be impractical. Because of these alternate approaches, the stationary source inventory is not a direct "slice" of the overall inventory, nor can it be directly compared. Nonetheless, the stationary sources inventory provides additional insight into the emission contributions by the state's largest emitters.

Under the federal Greenhouse Gas Reporting Rule, as of 2010, facilities emitting more than 25,000 metric tons of CO_2e are required to report their greenhouse gas emissions to EPA every year. EPA has collected and published data for 2010 and 2011. During the first two years of this reporting program, 31 organizations in Alaska reported emissions. The 2010 and 2011 data show very similar patterns for major sectors and owners. Exhibit 28 shows the 2010 emissions by sector and by facility owner. Exhibit 29 shows the emissions for both 2010 and 2011 by facility owner.

Exhibit 28 – 2010 Stationary Source Emissions by Sector and Organization

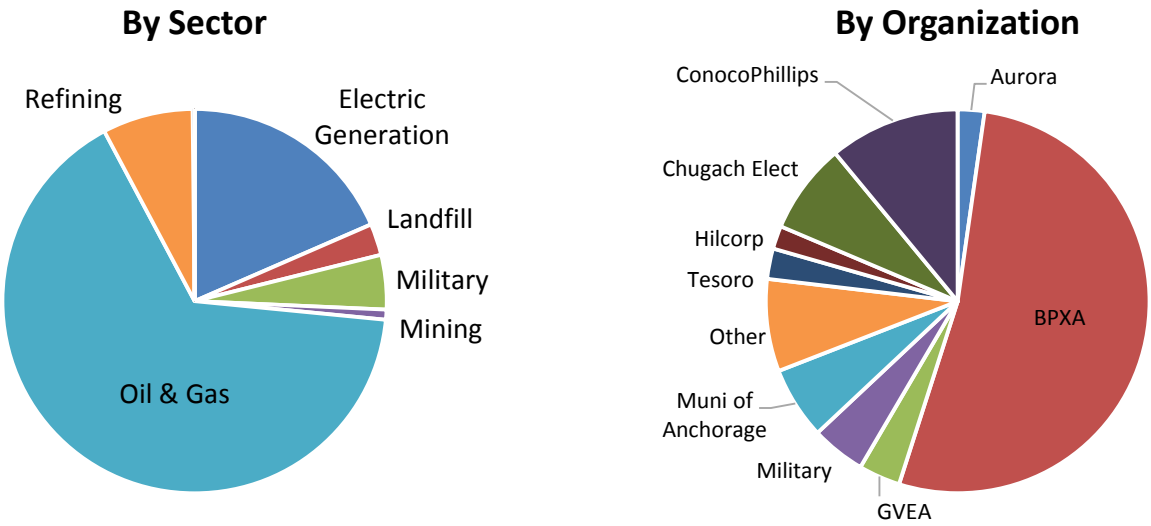


Exhibit 29 – Emissions Reported under GHG Reporting Rule

	Emissions (MT CO_2e)	
Owner	**2010**	**2011**
AK Electric & Energy Co-op	181,384	190,487
Alyeska	149,046	168,129
Aurora	390,101	349,941
Barrow Utilities	42,686	42,773
BPXA	9,208,430	11,082,731
Chugach Electric Assoc.	1,326,183	1,335,234
City of Unalaska	—[13]	29,616
Coeur AK	—	25,730
ConocoPhillips	1,909,699	2,610,907
Copper Valley Electric	27,094	15,952
Eni	—	32,916
Exxon Mobile	27,801	64,805
Fairbanks Natural Gas	5,252	1,898
Fairbanks North Star Borough	53,676	55,377
GVEA	608,868	579,671
Hecla Greens Creek Mine	—	27,017
Hilcorp	338,339	357,265
Kenai Peninsula Borough	41,034	43,113
Koch Industries (Flint Hills Refinery)	233,134	218,888
Marathon	35,172	58,970
Military	793,928	892,693
Municipality of Anchorage	1,056,174	1,096,073
Petro Star/ASRC	53,046	119,681
Pioneer	—	36,698
Red Dog	146,803	138,381
TAPS	110,153	122,442
TDX	31,471	48,052
Tesoro	446,365	547,227
UAF	137,465	134,607
Union	—	70,395
Unisea	28,050	23,365
Waste Management, Inc.	—	14,658
Total	17,381,356	20,535,692

[13] — indicates owners that did not report emissions in Alaska in 2010.

Future Work

This first greenhouse gas emissions inventory prepared by DEC establishes the protocols for the agency to be able to update Alaska's greenhouse gas inventory analysis as needed. This report identifies data sources and adjustments to the SIT to reflect the Alaskan landscape. In addition, the supporting files clearly document the approach for the inventory so that it can be repeated more easily in the future.

In addition to updating the inventory with additional years of data, future work could include projections beyond the current year or more in-depth analysis of specific sectors.

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Todd, Susan K., Jewkes, Holly Ann. Wildland Fire in Alaska: A History of Organized Fire Suppression and Management in the Last Frontier. Agriculture and Forestry Experiment Station Bulletin No. 114. University of Alaska Fairbanks. March 2006. http://www.uaf.edu/files/snras/B114.pdf, accessed on 8/30/2013.

Appendix A – Description of Data Sources

Each of the following exhibits corresponds to one of the modules that make up the SIT. Within each module, there are multiple tabs for inputs. The exhibits identify the data used for each tab within each module. The last exhibit includes data sources used for the transportation diesel adjustments.

Exhibit A1 – Agriculture Module

Tab	Data Description
Enteric Fermentation	Defaults used
CH4 from Manure management	Defaults used
N_2O from Manure Management	Data input in previous tab – defaults used
Ag Soils Plant Residues & Legumes	Barley and Oat production data input – http://www.nass.usda.gov/Statistics_by_State/Alaska/Publications/
Ag Soils Plant Fertilizers	Defaults used
Ag Soils Animals	Defaults used
Rice Cultivation	Defaults used – no rice cultivation in Alaska
Ag Residue Burning CH_4	Barley production data input – http://www.nass.usda.gov/Statistics_by_State/Alaska/Publications/
Ag Residue Burning N_2O	Data input in previous tab – input barley production

Exhibit A2 – Carbon Dioxide from Fossil Fuel Combustion

Tab	Data Description
State Energy Data Table	Defaults used
Residential	See transportation adjustments, Exhibit A12.
Commercial	Defaults used
Transportation	See transportation adjustments, Exhibit A12.
Electric Power	See transportation adjustments, Exhibit A12.
Bunker Fuels	Defaults used
Industrial	Defaults used

Exhibit A3 – Coal

Tab	Data Description
CH_4 from Coal Mining	Defaults used
CH_4 from Abandoned Coal Mines	Did not use this portion of the module due to insufficient inputs. Because most coal mining in Alaska is done via surface mines, abandoned mines contribute a negligible amount of the state's greenhouse gas emissions.

Exhibit A4 – Electricity Consumption

Tab	Data Description
EF Selection	Defaults used
Residential Consumption	Defaults used
Commercial Consumption	Defaults used
Transportation Consumption	Defaults used
Industrial Consumption	Defaults used

Exhibit A5 – Industrial Processes

Tab	Data Description
MRR Data Input	Defaults used
Cement	"Minerals Yearbook," USGS, 2004, pg. 16.13-14, footnote 3. Same footnote in 2000-2010 yearbooks, but not 1993-1999 yearbooks. http://minerals.usgs.gov/minerals/pubs/commodity/cement/index.html#mcs Deleted 2004 default data. The value did not fit with the information presented in the Minerals Yearbooks.
Lime	Defaults used
Limestone	Defaults used
Soda Ash	Defaults used
Iron & Steel	Defaults used
Ammonia & Urea	Defaults used
Nitric	Defaults used
Adipic	Defaults used
Aluminum	Defaults used
HCFC-22	Defaults used
ODS (ozone depleting substances)	Defaults used
Semiconductor	Defaults used
Electric Power	Defaults used
Magnesium	Defaults used

Exhibit A6 – Land Use, Land Use Change, Forestry

Tab	Data Description
Liming	Defaults used
Urea Fertilization	Defaults used
Settlement Soils	Defaults used
Urban Trees	Defaults used
Burning CH_4	1990 through 2005: Wildland Fire in Alaska: A History of Organized Fire Suppression and Management in the Last Frontier. http://www.uaf.edu/files/snras/B114.pdf 2006 through 2010: AICC – annual fire reports. http://fire.ak.blm.gov/predsvcs/intel.php
Burning N_2O	Defaults used
Yard Trimmings	Defaults used
C-Flux	Defaults used

Exhibit A7 – Mobile Combustion

Tab	Data Description
Highway 1 –N_2O factors	Defaults
Highway 1 –CH_4 factors	Defaults
Highway 1 – VMT	State VMT totals distributed among vehicle types based on default distribution. http://www.dot.alaska.gov/stwdplng/transdata/traffic_maps_home.shtml
Highway 2	Defaults
Highway 3	Defaults
Aviation	Defaults
Boats	Defaults
Locomotives	Defaults
Other	Defaults
AFV	Defaults

Exhibit A8 – Natural Gas and Oil

Tab	Data Description
Natural Gas Production	Defaults
Natural Gas Transmission	No defaults provided. Used data from Pipeline and Hazardous Materials Safety Administration: http://phmsa.dot.gov/portal/site/PHMSA/menuitem.ebdc7a8a7e39f2e55cf2031050248a0c/?vgnextoid=a872dfa122a1d110VgnVCM1000009ed07898RCRD&vgnextchannel=3430fb649a2dc110VgnVCM1000009ed07898RCRD&vgnextfmt=print
Natural Gas Distribution	No defaults provided. Use same source as Natural Gas Transmission.
Natural Gas Venting and Flaring	Defaults
Petroleum Systems	Defaults

Exhibit A9 – Solid Waste

Tab	Data Description
Flaring	Defaults
LFGTE	Defaults
State Population	Defaults
State Disposal	Defaults
State MSW Combusted	Defaults
CO_2 Plastics	Defaults
CO_2 Syn Rubber	Defaults
CO_2 Syn Fibers	Defaults

Exhibit A10 – Stationary Combustion

Tab	Data Description
State Energy Data	Modified wood energy. DNR and FNSB permits show increase in wood harvest in the last few years. Beginning in 2005, DOE methodology changed. Determined rate of increase from 1990 to 2004 and extended to subsequent years.
Residential N_2O	Defaults
Residential CH_4	Defaults
Commercial N2O	Defaults
Commercial CH_4	Defaults
Electric Power N_2O	Defaults
Electric Power CH_4	Defaults
Industrial N_2O	Defaults
Industrial CH_4	Defaults

Exhibit A11 – Wastewater

Tab	Data Description
Municipal WW CH_4	Defaults
Municipal WW N_2O, direct	Defaults
Municipal WW N_2O, effluent	Defaults
Ind WW Fruit	Defaults
Ind WW Meat	Defaults
Ind WW Poultry	Defaults
Ind WW P&P	Defaults

Exhibit A12 – Data sources for rural fuel use adjustments

Tab	Data Description
Rural population	Population tables provided by Alaska State Department of Commerce, Community, And Economic Development for all communities in the state for 1990, 2000, 2010, and 2012. Population for intervening years was interpolated.
Power Cost Equalization (PCE) Fuel Use	PCE reports provided by Alaska Energy Authority
Power Cost Equalization Population	PCE reports provided by Alaska Energy Authority
Portion of BTUs for residential heat	http://apps1.eere.energy.gov/states/consumption.cfm/state=AK
Portion of residential heat from distillate	http://apps1.eere.energy.gov/states/residential.cfm/state=AK#sources

Appendix B – Sector Results for All Years

Unless otherwise noted in the table, all emissions are in million metric tons carbon dioxide equivalents (MMT CO_2e)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Electricity Production	**3.05**	**2.91**	**2.74**	**2.77**	**2.79**	**2.87**	**3.00**	**3.21**	**3.38**	**3.48**	**3.62**	**3.70**	**3.73**	**3.43**	**3.64**	**3.69**	**3.96**	**3.74**	**3.73**	**3.65**	**3.51**
Coal	0.45	0.46	0.43	0.46	0.41	0.45	0.35	0.36	0.76	0.73	0.78	0.80	0.85	0.52	0.59	0.57	0.58	0.58	0.58	0.59	0.56
Natural Gas	1.87	1.67	1.54	1.49	1.54	1.59	1.66	1.78	1.53	1.62	1.89	1.74	1.70	1.83	2.01	2.10	2.31	2.19	2.31	2.03	2.12
Petroleum	0.73	0.78	0.77	0.82	0.83	0.84	0.99	1.07	1.09	1.13	0.95	1.17	1.18	1.07	1.04	1.02	1.07	0.96	0.84	1.02	0.83
Residential & Commercial	**4.36**	**4.45**	**4.82**	**4.82**	**4.86**	**4.95**	**5.22**	**4.99**	**5.15**	**5.46**	**5.27**	**5.09**	**4.62**	**4.54**	**4.94**	**4.90**	**5.35**	**4.97**	**5.03**	**4.68**	**5.02**
Coal	0.77	0.79	0.80	0.88	0.81	0.81	0.74	0.78	0.82	0.85	0.80	0.73	0.72	0.69	0.76	0.77	0.86	0.73	0.84	0.80	0.84
Natural Gas	1.80	1.83	1.90	1.79	1.89	2.15	2.29	2.23	2.27	2.41	2.32	1.75	1.70	1.82	1.95	1.86	2.09	2.06	2.06	1.95	1.85
Petroleum	1.78	1.81	2.11	2.14	2.14	1.97	2.18	1.96	2.05	2.20	2.14	2.59	2.17	2.01	2.21	2.24	2.38	2.16	2.11	1.91	2.30
Wood (CH_4 and N_2O)	0.012	0.013	0.013	0.016	0.015	0.015	0.016	0.013	0.012	0.012	0.013	0.021	0.022	0.023	0.023	0.019	0.019	0.020	0.020	0.021	0.022
Industrial	**24.87**	**26.55**	**27.85**	**27.45**	**26.62**	**29.45**	**30.11**	**28.30**	**28.34**	**26.76**	**26.33**	**26.38**	**26.90**	**26.54**	**25.63**	**27.02**	**23.21**	**23.36**	**21.33**	**21.04**	**20.26**
Coal/Coal Mining	0.026	0.022	0.023	0.027	0.032	0.025	0.026	0.026	0.022	0.026	0.026	0.025	0.019	0.017	0.024	0.024	0.025	0.023	0.022	0.034	0.038
Natural Gas/ NG Industry	13.95	16.17	17.22	17.44	16.36	19.27	19.56	18.45	19.07	18.08	18.70	18.22	18.77	18.30	17.66	19.13	15.70	15.69	14.28	14.43	14.12
Petroleum/Oil Industry	10.90	10.36	10.61	9.99	10.23	10.16	10.52	9.82	9.25	8.65	7.60	8.14	8.11	8.22	7.95	7.86	7.49	7.65	7.02	6.57	6.10
Transportation	**11.18**	**11.03**	**9.97**	**9.51**	**10.00**	**10.60**	**11.10**	**12.28**	**12.61**	**13.40**	**14.31**	**13.42**	**14.09**	**15.16**	**16.80**	**17.37**	**17.37**	**16.35**	**13.89**	**11.64**	**13.36**
Aviation	7.21	7.09	6.11	6.15	6.64	7.06	7.69	8.79	9.03	9.89	10.78	10.03	10.46	11.26	12.74	13.18	13.09	11.98	9.82	7.75	9.37
Marine	1.59	1.53	1.59	1.07	0.92	1.14	0.99	1.12	1.05	0.89	0.87	0.75	0.93	1.16	1.29	1.36	1.48	1.46	1.24	0.98	1.13
On-Road	2.33	2.36	2.23	2.25	2.40	2.36	2.39	2.33	2.48	2.59	2.62	2.60	2.65	2.66	2.70	2.75	2.73	2.84	2.77	2.85	2.81
Rail and Other	0.059	0.051	0.049	0.040	0.034	0.040	0.037	0.045	0.048	0.038	0.043	0.052	0.056	0.074	0.074	0.082	0.078	0.067	0.058	0.056	0.060
Industrial Processes	**1.10**	**1.23**	**1.35**	**1.33**	**1.42**	**1.40**	**1.31**	**1.25**	**1.28**	**1.29**	**1.17**	**1.00**	**1.16**	**1.06**	**1.15**	**1.14**	**0.48**	**0.47**	**0.26**	**0.27**	**0.29**
Ammonia Production	1.050	1.040	1.129	1.080	1.129	1.070	1.135	1.078	1.104	1.085	0.966	0.783	0.924	0.815	0.893	0.885	0.216	0.214	0.000	0.000	0.000
Urea Production	0.001	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Limestone & Dolomite Use	0.000	0.000	0.000	0.000	0.000	0.012	0.006	0.012	0.011	0.013	0.010	0.008	0.008	0.008	0.007	0.007	0.006	0.000	0.000	0.000	0.000
Cement Manufacture	0.000	0.139	0.173	0.193	0.214	0.207	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ODS Substitutes (HFC, PFC)	0.001	0.001	0.004	0.014	0.032	0.070	0.097	0.123	0.140	0.157	0.169	0.180	0.194	0.204	0.216	0.224	0.231	0.232	0.234	0.242	0.264
Soda Ash (CO_2)	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.005	0.005	0.005
Electric Power T&D	0.042	0.039	0.040	0.038	0.036	0.033	0.030	0.028	0.024	0.025	0.023	0.024	0.023	0.022	0.023	0.023	0.022	0.020	0.021	0.021	0.020
Waste	**0.32**	**0.35**	**0.31**	**0.32**	**0.33**	**0.34**	**0.35**	**0.36**	**0.38**	**0.39**	**0.40**	**0.42**	**0.43**	**0.43**	**0.43**	**0.45**	**0.47**	**0.49**	**0.50**	**0.52**	**0.53**
Solid Waste Management	0.27	0.30	0.26	0.27	0.28	0.28	0.29	0.31	0.32	0.33	0.34	0.35	0.37	0.37	0.37	0.39	0.40	0.42	0.44	0.45	0.46
Wastewater Management	0.052	0.054	0.056	0.057	0.057	0.057	0.058	0.058	0.059	0.060	0.060	0.061	0.062	0.063	0.064	0.065	0.066	0.066	0.067	0.068	0.069
Agriculture	**0.05**	**0.04**	**0.04**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.06**	**0.06**	**0.05**	**0.06**	**0.06**	**0.06**	**0.06**	**0.07**	**0.07**	**0.08**	**0.08**	**0.09**	**0.08**
Agricultural Soils	0.030	0.028	0.026	0.031	0.026	0.028	0.029	0.027	0.030	0.026	0.026	0.030	0.028	0.030	0.030	0.031	0.034	0.038	0.037	0.040	0.033
Enteric Fermentation	0.015	0.014	0.015	0.015	0.017	0.018	0.019	0.021	0.022	0.023	0.019	0.020	0.021	0.022	0.024	0.026	0.028	0.029	0.026	0.025	0.025
Manure Management	0.001	0.001	0.001	0.001	0.002	0.003	0.003	0.003	0.006	0.007	0.007	0.008	0.008	0.009	0.010	0.009	0.008	0.008	0.014	0.021	0.021
Gross Emissions	**44.93**	**46.55**	**47.09**	**46.25**	**46.07**	**49.67**	**51.13**	**50.43**	**51.21**	**50.83**	**51.16**	**50.07**	**50.98**	**51.21**	**52.66**	**54.64**	**50.92**	**49.45**	**44.81**	**41.88**	**43.04**
Emission Sinks	-6.50	-21.65	-30.17	-25.53	-29.01	-30.73	-26.41	-15.30	-30.15	-23.26	-25.20	-29.40	-14.09	-26.41	20.20	5.20	-29.04	-26.06	-30.31	-8.15	-22.37
Net Emissions	**38.43**	**24.90**	**16.93**	**20.72**	**17.06**	**18.94**	**24.72**	**35.13**	**21.07**	**27.57**	**25.96**	**20.67**	**36.89**	**24.80**	**72.86**	**59.84**	**21.87**	**23.39**	**14.50**	**33.74**	**20.67**
Increase Over 1990	**0.00**	**1.62**	**2.16**	**1.32**	**1.14**	**4.74**	**6.20**	**5.50**	**6.28**	**5.90**	**6.23**	**5.14**	**6.05**	**6.28**	**7.73**	**9.71**	**5.99**	**4.52**	**-0.12**	**-3.05**	**-1.89**
Increase Relative to 1990	**0%**	**4%**	**5%**	**3%**	**3%**	**11%**	**14%**	**12%**	**14%**	**13%**	**14%**	**11%**	**13%**	**14%**	**17%**	**22%**	**13%**	**10%**	**0%**	**-7%**	**-4%**
Emissions Per Person (MT)	**81.69**	**81.81**	**80.27**	**77.49**	**76.71**	**82.57**	**84.49**	**82.73**	**82.99**	**81.72**	**81.61**	**79.14**	**79.44**	**78.85**	**79.83**	**81.90**	**75.48**	**72.71**	**65.24**	**60.02**	**60.60**
EIA Estimate[14]	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**44.32**	**43.40**	**43.56**	**43.51**	**46.76**	**48.06**	**45.79**	**44.12**	**39.46**	**37.92**	**38.73**
EIA Per Capita (MT)[8]	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**70.60**	**68.51**	**67.86**	**67.18**	**70.93**	**72.05**	**67.81**	**64.89**	**57.56**	**54.58**	**54.63**

[14] http://www.eia.gov/environment/emissions/state/analysis/