**-DRAFT-**

# Alaska Department of Environmental Conservation

# Summary Report of Improvements to the Alaska Greenhouse Gas Emission Inventory

**January 2008**

# Improvements to the Alaska Greenhouse Gas Emission Inventory

## Introduction and Background

Global climate change is impacting Alaska. In Alaska, reported adverse impacts resulting from global warming include (Hassol, 2004):

- Increased coastal erosion and displacement of coastal communities;
- Melting of arctic tundra and taiga resulting in the damage of Alaska's infrastructure;
- Warmer summers resulting in insect infestations, more frequent and larger forest fires, and the alteration of Alaska's boreal forests;
- Decrease in arctic ice cover resulting in loss of habitat and prey species for marine mammals;
- Changes in terrestrial and oceanic species abundance and diversity resulting in the disruption of the subsistence way of life, among other adverse impacts.

The United Nation's Intergovernmental Panel On Climate Change reported that global climate change and the greenhouse effect have been linked to a steep rise in the atmospheric concentration of greenhouse gases (GHG) such as carbon dioxide ($CO_2$), methane, ($CH_4$), nitrous oxide ($N_20$), and synthetic halocarbons (chlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, halons and sulphur hexafluoride) (IPCC, 2007). For further information on the science relied upon by the IPCC linking the accumulation of greenhouse gases in the earth's atmosphere and global climate change refer to the Intergovernmental Panel on Climate Change (IPCC) website at www.ipcc.ch/ipccreports/ar4-wg1.htm (IPCC, 2007a).

Congress is debating several bills pertaining to climate change. Should legislation be enacted, mandatory GHG reduction targets could be established across the nation. Some states have already established statewide goals for reductions. In Alaska, Governor Palin established an executive sub-cabinet to consider the numerous aspects of climate change. This includes examining opportunities to reduce GHG emissions consistent with Alaska's best interest. This inventory of greenhouse gas emissions will be used by the Climate Change Sub-Cabinet as a foundation to explore opportunities to reduce emissions.

This summary report on Alaska's greenhouse gas emissions is a refinement to a February 2007 report entitled, "Alaska Greenhouse Gas Inventory and Reference Case Projections 1990-2020" prepared for Alaska by the Center for Climate Strategies (CCS) The CCS report contained the first comprehensive inventory and forecast of the State's GHG emissions from 1990 to 2020. This summary provides refined information on emissions from industrial and aviation sources and presents an update of the original CCS report.

## Overview of Alaska Greenhouse Gas Emissions Updates

The Alaska Department of Environmental Conservation's (ADEC) GHG emission inventory refinements result from two discrete efforts. ADEC worked to refine emission estimates for the industrial and transportation source groups, the two largest emission sources in the initial report (see Table 1) and concurrently reviewed the initial report for errors and areas needing clarifications. ADEC wanted to determine how GHG emissions were distributed between sources within these broad categories. ADEC's analysis of industrial sources took a first look at the emissions generated by specific subcategories of facilities. ADEC modifications to the transportation category involved an analysis of aviation emissions, a major GHG source in Alaska.

**Industrial Source Refinements**

To further identify industrial source contribution to the total GHG emissions, ADEC calculated emissions for Alaska's large industrial facilities. These facilities require an Operating permit by the State of Alaska which implements requirements of Title V of the federal Clean Air Act[1]. The operating permit has reporting requirements for fuel use and storage. Using the reported fuel use numbers, ADEC calculated GHG emission estimates for the larger permitted sources and then summarized the emissions into source categories. The results of the analysis showed Alaska industries with the highest greenhouse gas emission estimates are those engaged in the energy production and energy delivery business. This would mean Alaska's oil and gas companies and the energy utilities providing power to Alaskan households.

**Transportation Source Refinements**

ADEC's additional refinement to Alaska's transportation source emission estimates reveal commercial aviation emits the largest quantity of GHGs in the transportation category. Further, the air freight industry at the Anchorage International Airport (AIA) appears to be a major source of GHGs. The international air cargo industry strategically refuels at AIA to take advantage of favorable jet fuel prices. That fuel is primarily burned outside the state. A cursory analysis of the international flights in Anchorage suggests the international aviation market is a dominant component of the commercial aircraft emissions and may be contributing up to 60% of the total aviation GHG emissions in Alaska.

**CCS Report Updates**

ADEC contracted with E.H. Pechan & Associates, a member of the CCS team, to address concerns with the original CCS report. The CCS report was based on a template CCS used for a number of state greenhouse gas inventories that were developed concurrently. The formatting and methods used by CCS led ADEC to request clarification on a number of the report's conclusions, charts, and graphs. ADEC asked for additional information on data sources and definitions CCS used, pointed out discrepancies and typos, and provided other comments to the contractor during the spring and summer of 2007. The contractor provided a final update of the CCS report to ADEC in July 2007. Table 1

[1] Title V of the Clean Air Act governs emissions of air pollution from facilities emitting 100 tons or more per year of a criteria air pollutant (e.g. sulfur dioxide, carbon monoxide, particulate matter, nitrogen oxide) or 10 tons per year of a hazardous air pollutant (e.g. benzene, mercury, formaldehyde).

below provides an updated summary of GHG emissions estimated by CCS for Alaska by source group for the years 1990-2020 (Roe et al., 2007). Reported green house gas emission estimates are in Million Metric Tons of CO2 equivalents (MMtCO2e).

**Table 1. Alaska Historical and Reference Case GHG Emissions by Source (Roe et al, 2007)**

| Source Group | 1990 | 2000 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|
| Electricity Production | 2.6 | 3.1 | 3.2 | 3.6 | 3.7 |
| Residential & Commercial | 3.8 | 4.3 | 3.9 | 3.9 | 4.2 |
| Total Industrial[2] | 20.6 | 22.8 | 24.6 | 26.4 | 30.6 |
| Transportation | 15.1 | 16.8 | 19.0 | 19.6 | 20.5 |
| Industrial Processes | 0.05 | 0.2 | 0.3 | 0.5 | 0.7 |
| Waste Management | 0.6 | 0.9 | 1.0 | 1.2 | 1.7 |
| Agriculture | 0.05 | 0.05 | 0.05 | 0.06 | 0.07 |
| **Total Gross Emissions** | **42.8** | **48.3** | **52.1** | **55.2** | **61.5** |

**Comparison of ADEC and CCS Results for Industrial Sources**

The ADEC analysis of industrial sources and the initial CCS GHG emission inventory found similar results. Within the industrial category, ADEC's total emission estimates for the industrial category were nearly the same as the total industrial source estimates in the original report. The methods to calculate these numbers were different, and the similarity in results provides some confidence in the magnitude of emissions reported. Further, both reports found the Residential-Commercial-Industrial (RCI) category had the highest GHG emission estimates. The RCI category includes Alaskan industries combusting, refining, storing and transporting the most fossil fuel. This makes sense as the primary greenhouse gas pollutants, carbon dioxide and methane, are released in the processing and combustion of fossil fuels.

The following table summarizes the results from the CCS report and ADEC refinements. The numbers reflect general estimates and are derived from different methods. The intent of the table and associated chart is to allow some comparison of the magnitude of contribution from differing source categories. Estimates are for 2005 except for the Title V estimates which are for 2002. Since the Title V emission sources do not encompass the full range of industrial emitters within the state, the 2002 Title V emission estimates are identified as subcategories of the overall 2005 emission estimates from the CCS report. This provides some indication of the magnitude of the Title V source subcategories within the broader source groups. However, it should be duly noted that the Title V source emissions in 2005 will not be exactly the same as what was emitted in 2002.

[2] Total Industrial combines the Industrial (Non-Fossil Production) and Fossil Fuel Industry emission estimates from the CCS report.

**Table 2. Breakdown of 2005 Emissions by Source Category**
**(Applying ADEC refinements and July 2007 CCS Updates)**

| Source Group | $MMTCO_2e$ |
|---|---|
| **Electricity Production** | |
| Electricity Production - Title V | 2.18 |
| Electricity Production - Non-Title V | 1.02 |
| **Total Electricity Production** | **3.2** |
| **Residential & Commercial** | |
| Residential & Commercial - Title V Municipal | 0.012 |
| Residential & Commercial - Title V Other | 0.007 |
| Residential & Commercial - Non-Title V | 3.881 |
| **Total Residential & Commercial** | **3.9** |
| **Industrial** | |
| Industrial - Title V Mining | 0.017 |
| Industrial - Title V Oil & Gas | 15.26 |
| Industrial - Title V Seafood | 0.16 |
| Industrial - Title V Other | 1.737 |
| Industrial - Non-Title V | 7.426 |
| **Total Industrial** | **24.6** |
| **Transportation** | |
| Transportation - Aviation - Commercial - Domestic | 4.59 |
| Transportation - Aviation - Commercial -International | 7.65 |
| Transportation - Aviation - Commercial | 12.236 |
| Transportation - Aviation - General Aviation | 0.2479 |
| Transportation - Aviation -Military | 0.2477 |
| Transportation - Aviation | 12.7 |
| Transportation - Marine Vessels | 2.4 |
| Transportation - On-road Vehicles | 3.6 |
| Transportation - Rail & Other | 0.12 |
| **Total Transportation** | **18.8** |
| **Waste Management** | |
| Waste Management - Title V | 0.019 |
| Waste Management - Non-Title V | 0.981 |
| **Total Waste Management** | **1** |
| **Industrial Processes** | **0.3** |
| **Military - Title V** | **0.97** |
| **Agriculture** | **0.05** |
| **Total Gross Emissions** | **52.82** |

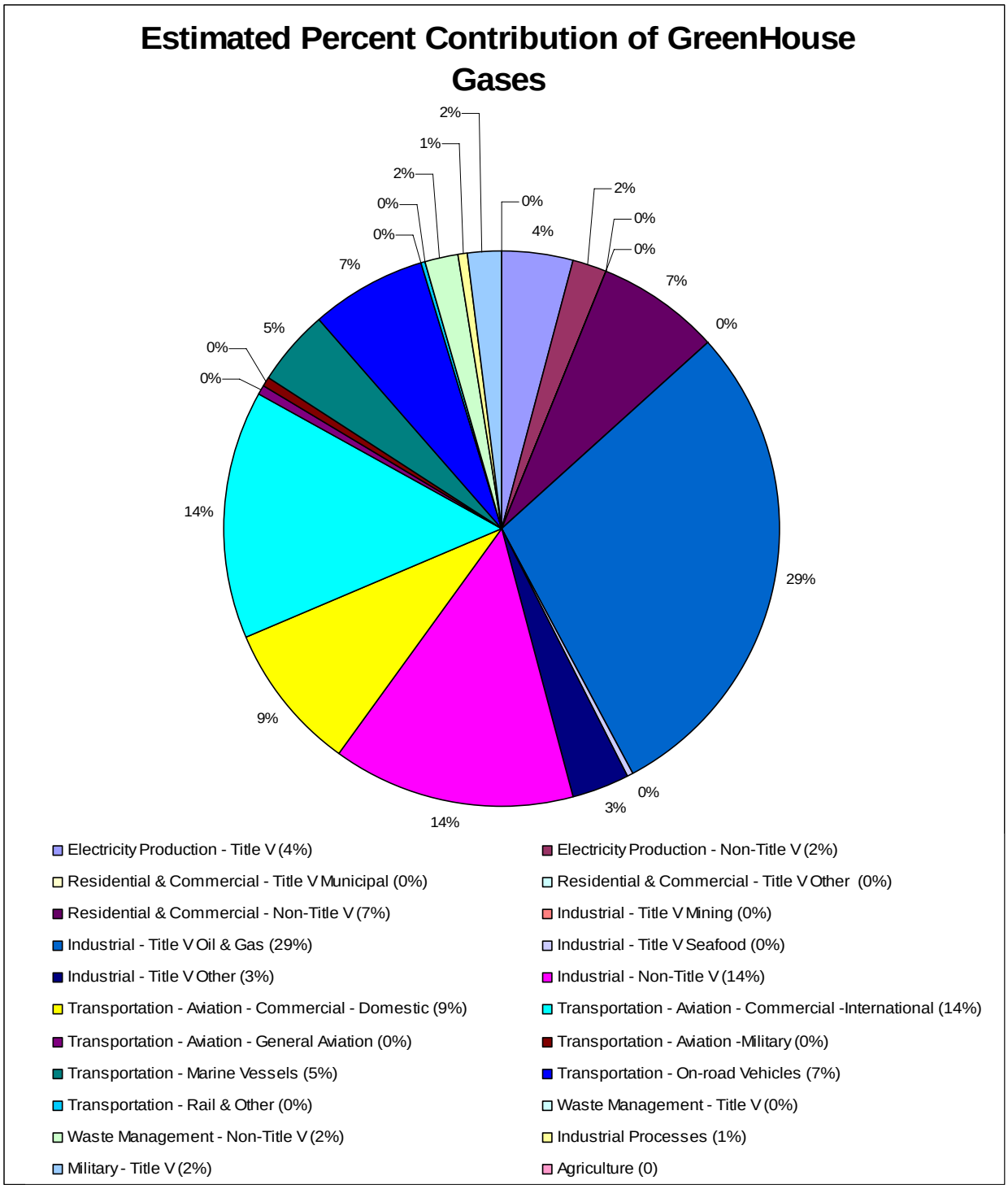


Figure 1. GHG Emission Percentages from CCS and ADEC Estimates

The remainder of this executive summary elaborates further on ADEC's efforts to refine the GHG emission inventory. In addition, the report's appendices provide more in-depth detail on this work.

## ADEC Refinements to the CCS Greenhouse Gas Emission Inventory

The release of the CCS GHG EI in February 2007 was met with keen interest. The report provided a first look at GHG emissions in Alaska. However, the report's summation of emissions from broad source categories did not allow for emission estimates from specific subcategories within transportation and industry sectors. In March 2007, the Trustees for Alaska requested ADEC require large emitters of GHGs to quantify and report their emissions. In responding to the Trustees for Alaska, ADEC committed to refine the GHG emission estimates for major industrial and transportation sources in Alaska. The following section summarizes the results of ADEC's efforts.

### ADEC Refinements to the Industrial Emission Estimates

ADEC staff identified the Alaskan industries having the potential to emit the greatest amount of GHGs through its permit program records. ADEC permits these major sources of traditional air pollutants through state laws that are designed to implement the Title V provisions of the federal Clean Air Act. A Title V operating permit requires a facility to report the fuel stored and used in its processes. ADEC gathered fuel data for 2002 for all Title V permitted facilities. Using a conversion factor that converts fuel volumes into GHG emissions, ADEC calculated GHG emissions for these sources based on actual fuel throughput. The total 2002 GHG emissions for the Title V sources were 20.63 MMtCO2e. The Title V greenhouse gas emission estimates by company are presented in Table 2.

ADEC assigned each company with a Title V permit to one of seven categories: electricity production, oil & gas development, seafood processing, mining, military, municipal, and "other". Table 3 provides the total GHG emissions by category. The category having the largest GHG emissions was oil & gas with 15.26 MMtCO2e of the total 20.63 MMtCO2e from Title V facilities (the total for all industrial was 24.6 MMtCO2e). Figure 2 shows a breakdown of the Title V emissions by category. The complete ADEC report, "Title V Greenhouse Gas Emission Inventory for Alaska," is found in Appendix A. As shown, the oil and gas source category was accountable for the largest percentage of GHG emissions from a single sector at 73% of Title V sources and 29% of all statewide emissions.

One of the major improvements to the industrial estimates as refined by ADEC is that the Title V source emissions were calculated based on fuel consumed. The original CCS method relied on fuel sales, which could include fuels stored at Alaska's terminal port facilities and fuels transported in pipelines. These fuels were not necessarily consumed in Alaska. Therefore, the CCS greenhouse gas emission inventory may overestimate the amount of fuel consumed in-state by Title V facilities and the industrial source category. Further differences between the ADEC and CCS estimates are examined in the appendices. Although the methodologies used by ADEC and CCS were different, the overall results were similar. Both methods conclude that industries in Alaska combusting, refining, storing and transporting fuel had the highest GHG emission estimates.

**Table 2. Greenhouse Gas Emission Inventory Results for Title V Sources in Alaska, 2002**

| Alaska's Title V Permittee/Company Name | GHG Emissions ($MMtCO_{2e}$) | % of Total Title V Emissions | ADEC Source Category | CCS Source Category (Roe et al., 2007) |
|---|---|---|---|---|
| Agrium US Inc | 1.737 | 8.424 | Other | Industrial (nff)[3] |
| Alaska Electric Light & Power | 0.002 | 0.009 | Electricity Production | Electricity Production |
| Alaska Power & Telephone | 0.008 | 0.040 | Electricity Production | Electricity Production |
| Alaska Railroad Corporation | 0.007 | 0.032 | Other | Residential/Commercial |
| Alyeska Pipeline Service Co. | 0.637 | 3.090 | Oil & Gas | Industrial (nff) |
| Alyeska Seafoods Inc. | 0.017 | 0.084 | Seafood Processing | Industrial (nff) |
| Anchorage Water & Wastewater Utility | 0.001 | 0.003 | Municipal | Residential/Commercial |
| Aurora Energy LLC | 0.294 | 1.425 | Electricity Production | Electricity Production |
| Bethel Utility Corporation | 0.031 | 0.150 | Electricity Production | Electricity Production |
| BP Exploration (Alaska) Inc. | 10.666 | 51.713 | Oil & Gas | Industrial (nff) |
| Capitol Disposal | 0.019 | 0.092 | Other | Residential/Commercial |
| Chugach Electric Association | 1.070 | 5.186 | Electricity Production | Electricity Production |
| City & Borough of Yakutat | 0.005 | 0.023 | Municipal | Residential/Commercial |
| City of Ketchikan | 0.010 | 0.049 | Municipal | Residential/Commercial |
| ConocoPhillips Alaska Inc | 2.405 | 11.660 | Oil & Gas | Industrial (nff) |
| Cook Inlet Pipe Line Company | 0.009 | 0.042 | Oil & Gas | Industrial (nff) |
| Copper Valley Electric Assoc. | 0.034 | 0.164 | Electricity Production | Electricity Production |
| Cordova Electric Cooperative | 0.008 | 0.037 | Electricity Production | Electricity Production |
| Flint Hills Resources Alaska | 0.349 | 1.692 | Oil & Gas | Industrial (nff) |
| Forest Oil Corporation | 0.012 | 0.060 | Oil & Gas | Industrial (nff) |
| Golden Valley Electric Association | 0.686 | 3.325 | Electricity Production | Electricity Production |
| Halliburton Energy Services | 0.005 | 0.026 | Oil & Gas | Industrial (nff) |
| Icicle Seafoods Incorporated | 0.010 | 0.048 | Seafood Processing | Industrial (nff) |
| Kennecott Greens Creek Mining Co. | 0.015 | 0.071 | Mining | Industrial (nff) |
| Kotzebue Electric Association | 0.014 | 0.069 | Electricity Production | Electricity Production |
| Marathon Oil Company | 0.029 | 0.141 | Oil & Gas | Industrial (nff) |
| Nome Joint Utility System | 0.018 | 0.088 | Electricity Production | Electricity Production |
| Nushagak Electric Cooperative | 0.012 | 0.060 | Electricity Production | Electricity Production |
| Peter Pan Seafoods | 0.016 | 0.077 | Seafood Processing | Industrial (nff) |
| Teck Cominco Alaska, Inc. | 0.153 | 0.743 | Mining | Industrial (nff) |
| Tesoro Alaska Petroleum Co. | 0.349 | 1.690 | Oil & Gas | Industrial (nff) |
| Trident Seafoods | 0.056 | 0.271 | Seafood Processing | Industrial (nff) |
| UniSea, Inc. | 0.040 | 0.196 | Seafood Processing | Industrial (nff) |
| University of Alaska | 0.107 | 0.518 | Municipal | Residential/Commercial |
| UNOCAL | 0.746 | 3.618 | Oil & Gas | Industrial (nff) |
| US Air Force | 0.584 | 2.833 | Military | Industrial (nff) |
| US Army | 0.388 | 1.879 | Military | Industrial (nff) |
| Westward Seafoods, Inc. | 0.025 | 0.119 | Seafood Processing | Industrial (nff) |
| XTO Energy, Inc. | 0.052 | 0.251 | Oil & Gas | Industrial (nff) |
| **Total Emissions** | **20.625** | **100%** | --- | --- |

[3] nnf = CCS non-fossil fuel related industrial sources includes GHG emissions associated with fuel consumed by the fossil fuel production industry.

**Table 3. Title V GHG Emissions & Percentages by ADEC Source Category**

| ADEC Source Category | Total GHG Emissions ($MMtCO_{2e}$) | % of Total Title V GHG Emissions |
|---|---|---|
| Electricity Production | 2.18 | 11% |
| Military | 0.97 | 5% |
| Mining | 0.017 | 1% |
| Municipal | 0.012 | 1% |
| Oil & Gas | 15.26 | 73% |
| Other | 1.76 | 8% |
| Seafood | 0.16 | 1% |
| **Totals** | **20.63** | **100%** |

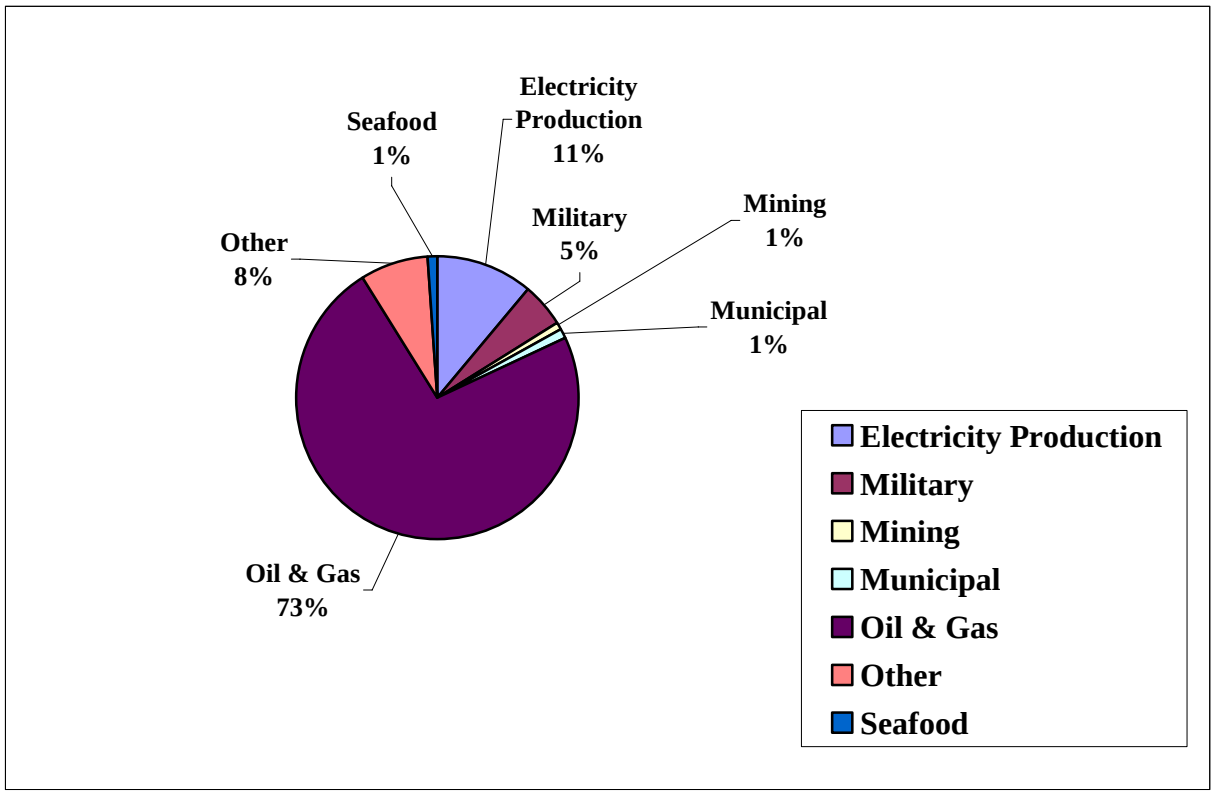


**Figure 2. Title V GHG Emission Percentages by ADEC Source Category**

## ADEC Refinements to the Aviation Emission Estimates

The CCS report found the aviation subcategory accounted for the largest share of greenhouse gas emissions from Alaska's transportation sources. The CCS GHG EI results for Alaska's transportation sources are summarized in Table 4 (Roe et al., 2007).

**Table 4. CCS Greenhouse Gas Emission Estimates for Alaska's Transportation Sources ($MMtCO_{2e}$)** (Roe et al., 2007).

| Source Group | 1990 | 2000 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|
| Aviation | 7.2 | 10.6 | 12.7 | 13.0 | 12.9 |
| Marine Vessels | 4.4 | 2.4 | 2.4 | 2.6 | 3.0 |
| On-road Vehicles | 3.4 | 3.7 | 3.6 | 3.9 | 4.4 |
| Rail & Other | 0.08 | 0.08 | 0.12 | 0.13 | 0.14 |
| **Totals** | **15.1** | **16.8** | **18.8** | **19.6** | **20.5** |

Aviation activity is commonly categorized into three types of operations: commercial, general, and military aviation. Commercial aviation includes both international and domestic flights carrying passenger, cargo or both. General aviation includes operations by private aircraft and fleets. Military aviation includes only those operations occurring on Alaska's military bases. Based on the initial CCS results, ADEC was interested in which of these types of aircraft operation (commercial, general, military) contributes the most GHG emissions in Alaska. Further, ADEC wanted to determine what portion of the commercial aircraft emissions were from international, versus domestic, flights.

In July 2007, ADEC's contractor estimated GHG emissions from Alaska's commercial, general and military aviation source groups for the years 1990-2005. Table 5 summarizes the results. Of the three subcategories, commercial aviation is by far the largest generator of GHG emissions.

Based on the allocation of aviation emissions into the three subcategories of operation, ADEC was able to turn its attention to the question of international and domestic flight operations. International flights frequently stop in Alaska for fuel. That fuel is then combusted within and outside of the state as the aircraft flies to its final international destination.

ADEC performed a cursory analysis to determine the contribution of international flights to aviation's GHG emissions. Based on personal communications with the Aircraft Service International Group, the primary provider of fuel to Ted Stevens Anchorage International Airport (AIA), approximately 92% of the fuel delivered to the airport is for international flights (pers. comm. to J. Murphy, 2007). Further, data showed that AIA consumes nearly 67% of jet fuel in Alaska. Based on this, ADEC's rough estimates show international flights consuming the majority of all jet fuel sold in Alaska.

Table 6 allocates the percent contribution of greenhouse gas from commercial, general and military aircraft in Alaska in 2005. Table 6 also includes a breakdown of domestic and international commercial flights. Figure 3 shows the aviation emissions by subcategory including the estimated split between domestic and international commercial flights. For the complete analysis of aviation emissions, refer to Appendix B.

**Table 5. Alaska Aviation Emissions Allocated by Subcategory**

| GHG Emissions from Aircraft, (MMtCO2e) | | | |
|---|---|---|---|
| **Year** | **Commercial** | **General Aviation** | **Military** |
| 1990 | 6.6403 | 0.1394 | 0.2982 |
| 1991 | 6.5813 | 0.1233 | 0.2968 |
| 1992 | 5.6815 | 0.0978 | 0.2269 |
| 1993 | 5.6549 | 0.0854 | 0.2574 |
| 1994 | 6.0970 | 0.1018 | 0.2632 |
| 1995 | 6.5190 | 0.1073 | 0.2419 |
| 1996 | 7.1662 | 0.1120 | 0.1919 |
| 1997 | 8.1289 | 0.1609 | 0.2455 |
| 1998 | 8.4779 | 0.1832 | 0.2260 |
| 1999 | 9.4222 | 0.2280 | 0.2304 |
| 2000 | 10.0342 | 0.1967 | 0.2506 |
| 2001 | 9.3592 | 0.1961 | 0.2283 |
| 2002 | 10.6094 | 0.2172 | 0.2237 |
| 2003 | 11.1310 | 0.2226 | 0.2309 |
| 2004 | 11.6539 | 0.2303 | 0.2603 |
| 2005 | 12.2360 | 0.2479 | 0.2477 |
| 2006 | 12.2413 | 0.2480 | 0.2478 |
| 2007 | 12.2466 | 0.2481 | 0.2480 |
| 2008 | 12.2520 | 0.2482 | 0.2481 |
| 2009 | 12.2573 | 0.2483 | 0.2482 |
| 2010 | 12.2626 | 0.2484 | 0.2483 |
| 2011 | 12.2338 | 0.2479 | 0.2477 |
| 2012 | 12.2051 | 0.2473 | 0.2471 |
| 2013 | 12.1764 | 0.2467 | 0.2465 |
| 2014 | 12.1478 | 0.2461 | 0.2460 |
| 2015 | 12.1192 | 0.2455 | 0.2454 |
| 2016 | 12.0726 | 0.2446 | 0.2444 |
| 2017 | 12.0261 | 0.2437 | 0.2435 |
| 2018 | 11.9799 | 0.2427 | 0.2426 |
| 2019 | 11.9338 | 0.2418 | 0.2416 |
| 2020 | 11.8879 | 0.2409 | 0.2407 |

**Table 6. Alaska Aviation Emissions Allocated by Subcategory for 2005, Including Domestic and International Commercial Flights**

| GHG Emissions by Aviation Subcategory, MMtCO2e (%) | | | | |
|---|---|---|---|---|
| | Commercial | | | |
| Year | Domestic | International | General Aviation | Military |
| 2005 | 4.59 (36%) | 7.65 (60%) | 0.25 (2%) | 0.25 (2%) |

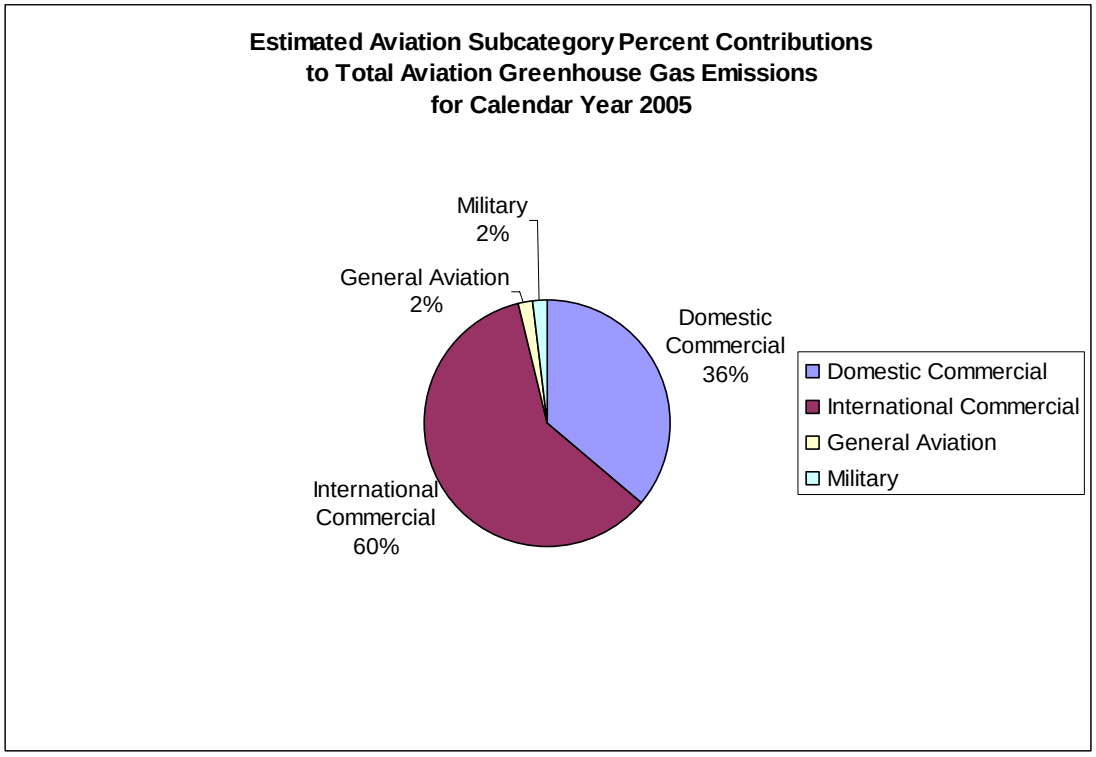


**Figure 3. Aviation Subcategory Emission Percentages**

**Center for Climate Strategies (CCS) Report Update of July 2007**

The February 2007 CCS report was the first comprehensive inventory and forecast of Alaska's GHG emissions. The report covered the years 1990 to 2020. The CCS greenhouse gas emission estimates were primarily based on statewide fuel sales data. The data represents all fuel sold in Alaska and does not differentiate fuels transported and burned out-of state with fuels burned in-state. CCS quantified emissions for the six greenhouse gases: carbon dioxide ($CO_2$), methane, ($CH_4$), nitrous oxide ($N_20$), hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride. All GHG emission estimates were converted to million metric tons of $CO_2$ equivalent ($MMtCO_2e$). CCS also grouped GHG emission estimates by the following source categories: Electricity Production; Residential & Commercial; Industrial (non-fossil fuel production); Transportation; Fossil Fuel Industry; Industrial Processes; Waste Management; and Agriculture.

Following the release of the CCS report, ADEC contracted with E.H. Pechan & Associates (a member of the CCS team) to make further edits and corrections to the original report. The second edition of the CCS report was published in July 2007 and can be found in its entirety in Appendix C (Roe et al., 2007). Table 7 provides the updated summary of GHG emissions estimated by CCS for Alaska by major source group for the years 1990-2020 (Roe et al., 2007). The primary corrections made were to the transportation source group emissions, which were updated for both the aviation and rail subcategories.

**Table 7. Alaska Historical and Reference Case GHG Emissions by Source (Roe et al, 2007)**

| Source Group | 1990 | 2000 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|
| Electricity Production | **2.6** | **3.1** | **3.2** | **3.6** | **3.7** |
| Residential & Commercial | **3.8** | **4.3** | **3.9** | **3.9** | **4.2** |
| Total Industrial[4] | **20.6** | **22.8** | **24.6** | **26.4** | **30.6** |
| Industrial (fuel combustion, transport, storage) | 15.7 | 19.6 | 21.6 | 23.5 | 28.5 |
| Industrial (fugitive methane release) | 4.9 | 3.2 | 3.0 | 2.9 | 2.1 |
| Transportation | **15.1** | **16.8** | **19.0** | **19.6** | **20.5** |
| Industrial Processes | **0.05** | **0.2** | **0.3** | **0.5** | **0.7** |
| Waste Management | **0.6** | **0.9** | **1.0** | **1.2** | **1.7** |
| Agriculture | **0.05** | **0.05** | **0.05** | **0.06** | **0.07** |
| Total Gross Emissions | **42.8** | **48.3** | **52.1** | **55.2** | **61.5** |

Note: All green house gas emission estimates are in Million Metric Tons of $CO_2$ equivalents ($MMtCO_2e$).

[4] One point of confusion with the CCS report has been the difference between the "non-fossil fuel production" and "fossil fuel" industry categories. Both of these categories are industrial, but one deals with emissions from the combustion of fuel ("non-fossil fuel production") while the other estimates the methane emissions released during the extraction of a fossil fuel resource from the earth ("fossil fuel industry"). To clarify the total emissions associated with industrial activities, ADEC combined the "fossil fuel" industry numbers with the industrial source category to provide an overall picture of industrial emissions.

## Results and Findings

The major findings of the Alaska Greenhouse Gas Inventory and Projection report are as follows:

- In 2005, total GHG emissions for Alaska were 52.8 million metric tons of *gross* carbon dioxide equivalent ($MMtCO_2e$), (gross emissions exclude carbon sinks, such as forests). This is an amount equal to about 0.7% of total United States gross GHG emissions. (According to EPA's Energy CO2 Emissions by State, emissions from the combustion of fuel in Alaska are about the same as Connecticut, Nevada, and North Dakota. Alaska's emissions are about half of Washington's emissions from fuel combustion, even though Washington has nearly 10 times Alaska's population.)

- The principal source of Alaska's GHG emissions is residential, commercial, and industrial (RCI) fuel use, accounting for 49% of total state gross GHG emissions in 2005. Nearly 85% of the RCI fuel use emissions are contributed by the industrial fuel use subcategory. The industrial subcategory accounts for around 41.5% of the gross GHG emissions in Alaska.

- Transportation sources accounted for approximately 36.5% of the gross GHG emissions in Alaska.

- Jet fuel consumption accounted for the largest share of the transportation GHG emissions in Alaska.

- Alaska's gross GHG emissions increased 13% from 1990 to 2000, while national emissions rose by 14% during this same time period.

- Based on refined estimates of emissions from large facilities, the oil & gas industry appears to be a key industrial source of greenhouse gas emissions in Alaska.

- Commercial aviation accounts for 96% of aviation's contribution to GHG emissions in the transportation source category.

- International aviation, as a sub-division of commercial aviation, appears to be a large GHG emission source and may account for roughly 60% of the emissions from aviation sources.

- Cars and trucks and other "mobile" sources account for around 7% of total emissions in Alaska. The percentage can be much higher in other states.

- Alaska's electricity production accounts for about 6% of Alaska's total GHG emissions. Power generation is a major source of greenhouse gas emissions for many states.

This refined emission inventory provides a baseline for manmade GHG emissions in Alaska. Identifying the source categories and associated GHG emissions allows for an exploration and deliberation of policy choices that could stem the growth or reduce the quantity of future emissions as part of an overall state strategy on climate change.

Because the inventory is focused only on manmade sources of GHGs, readers should understand the inventory does not represent total comprehensive statewide emissions. There are natural sinks and sources of carbon dioxide and methane including what is sequestered in frozen tundra, ice caps, and oceans and what is emitted during forest fires and natural biological digestion of organic materials.

Furthermore, this effort was not designed to undertake a forecasting of future emission rates that may be associated with various growth scenarios for Alaska. Though possibly very important to policy choices as a state strategy is developed, these projections were outside the scope of this initial effort.

## Recommendations for Future Work

The development of greenhouse gas emission inventories is new to ADEC and improvements can always be made to better characterize the sources of emissions. These baseline estimates of greenhouse gas emissions in Alaska provide a foundation to better identify and prioritize greenhouse gas sources. Future policy needs may warrant development of more refined emission estimates for specific source categories. If this occurs, ADEC may initiate development of a more detailed GHG EI for Alaska.

Any future efforts to develop a more detailed GHG EI for Alaska may include:

- The development of a standardized protocol to incorporate the inventory of green house gases into our existing emission inventory work;
- The collection of additional data and improvement to emission factors;
- The continued identification and correction of data gaps in the original February 2007 report;
- Continued refinement of estimates for large source categories such as power generation, oil and gas, and transportation, including more analysis on the impacts of commercial passenger and cargo flights;
- Calculation of fugitive emissions of GHG associated with energy production and transport of the fuel to markets;
- Analysis of the contribution of natural sources of GHG

As climate change impact scenarios and policy needs evolve, there may also be a need to calculate future emissions for various scenarios of interest. The 2010 and 2020 reference case emission projections from the initial February 2007 report provide a starting point. As projection needs are determined, ADEC may initiate additional inventory efforts to provide the data needed for policy decisions.

Alaska is moving ahead in developing a climate change strategy. ADEC welcomes feedback on this emission inventory report and the development of the Alaska Climate Change Strategy.