Appendix A

Greenhouse Gas Emissions Inventory

For

Title V Sources

In the State of Alaska

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List of Abbreviations

AAC	Alaska Administrative Code
AD	Activity Data
ADEC	Alaska Department of Environmental Conservation
AQD	Air Quality Division
Btu	British Thermal Units
CAA	Clean Air Act
CCS	Center for Climate Strategies
CH_4	Methane
CO_2	Carbon Dioxide
EF	Emission Factor
EI	Emission Inventory
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
GHG	Greenhouse Gas
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
MMBtu	Million British Thermal Units
$MMtCO_{2e}$	Million Metric Tons Carbon Dioxide Equivalents
N_2O	Nitrous Oxide
QA	Quality Assurance
QC	Quality Control
SCC	Standard Classification Code
SGIT	State Greenhouse Inventory Tool

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1.0 Introduction

In February 2007, the Center for Climate Strategies (CCS) completed a report for Alaska entitled "Alaska Greenhouse Gas Inventory and Reference Case Projections 1990- 2020" (Roe et al., 2007). The CCS report contained the first comprehensive inventory and forecast of Alaska's GHG emissions from 1990 to 2020. The report quantified GHG emissions by the following sources in Alaska: Electricity Production; Residential & Commercial; Industrial (non-fossil fuel production); Transportation; Fossil Fuel Industry; Industrial Processes; Waste Management; and Agriculture. Six types of greenhouse gases (GHG) were quantified: carbon dioxide (CO_2), methane, (CH_4), nitrous oxide (N_20), hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride. Total emissions were quantified for each of the six GHG and converted to million metric tons of CO_2 equivalent ($MMtCO_2e$)based on their respective global warming potential. Not all six GHG were quantified for each source.

Table 1 provides a summary of GHG emissions, estimated by CCS, for Alaska by source for the years 1990, 2000, 2005, 2010, and 2020 (Roe et al., 2007). The GHG emission estimates for 2010 and 2020 were based on projected energy consumption for each source and various assumptions stated in the report.

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
Industrial (non-fossil fuel production)*	15.7	19.6	21.6	23.5	28.5
Transportation	15.1	16.8	19.0	19.6	20.5
Fossil Fuel Industry*	4.9	3.2	3.0	2.9	2.1
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 GHG emissions are in Million Metric Tons of CO_2 equivalents ($MMtCO_2e$).

The CCS report concluded that, in 2005, activities in Alaska accounted for approximately 52.1 million metric tons (MMt) of gross GHG emissions, an amount equal to 0.7% of total United States gross GHG emissions (Roe et al., 2007). The CCS report concluded that industrial (non-fossil fuel production) and transportation sources accounted for approximately 41.5% and 36.5% of the gross GHG emissions in Alaska, respectively. The CCS industrial (non-fossil fuel production) source group includes industries in Alaska which combust, transport and store fossil

* The CCS source groups "non-fossil fuel production" and "fossil fuel" industry categories are both "industrial". One deals with emissions from the combustion of fuel (the "non-fossil fuel production" source group) while the other estimates the methane emissions released during the extraction of a fossil fuel resource from the earth (the "fossil fuel industry" source group). In the executive summary, ADEC combined the "fossil fuel" industry numbers with the industrial source category to provide an overall picture of industrial emissions.

fuel. ADEC's Title V[†] GHG EI further defines greenhouse gas emissions as they relate to specific industries within this source group and within Alaska's energy sector. The complete CCS report (Roe et al., 2007) is found at www.climatechange.alaska.gov/doc-links.htm.

The release of the CCS report in 2007 was met with much interest by industry and the public in Alaska. The report provides a foundation of information on GHG emissions in Alaska. The reports broad emission source categories did not define the relative impacts of source sub-categories; such as the contribution of oil and gas extraction within the industrial source sector. Following the release of the CCS report, the Trustees for Alaska requested that the Alaska Department of Environmental Conservation (ADEC) require emitters of significant amounts of GHG emissions in Alaska to quantify and report those emissions and fuel usage. ADEC, in its response to the Trustees for Alaska, indicated that the Department would work to develop a more detailed GHG emission inventory during 2007.

1.1 Title V GHG EI Objectives

The primary objectives of this study were to:

· Conduct a greenhouse gas emissions inventory (GHG EI) for carbon dioxide, methane and nitrous oxide released from fossil fuels combusted at Title V stationary sources in Alaska.

· Quantify a portion of Alaska's energy sector greenhouse gas contributions.

· Compare these findings to conclusions stated in the CCS report (Roe et al., 2007).

ADEC's Division of Air Quality permitting program is responsible for issuing air quality operating permits under authority of the Federal Clean Air Act (CAA) and state law. Under this authority, ADEC issues permits for Alaska's major stationary sources, also known as Title V sources under the CAA, according to Alaska Administrative Code (AAC) found at 18 AAC 50 Article 3- Major Stationary Source Permits.

ADEC maintains a database called AIRTOOLS. AIRTOOLS was custom designed and built to help manage ADEC's Title V facility data associated with air permitting, compliance, and emission inventory. AIRTOOLS contains emission rates and fuel used by specific Title V facilities in Alaska. These data are reported to ADEC as required under their Title V permit or to meet federal requirements for emission reporting. ADEC routinely conducts emission inventories based on these reported emissions for regulated air pollutants. Inventoried pollutants include carbon monoxide, sulfur oxides, nitrogen dioxide, ozone and particulate matter. The results of the emission inventories are reported to the U.S. Environmental Protection Agency (EPA) every three years.

[†] "Title V" refers to the section of the Clean Air Act regulating the permitting of large stationary sources of air pollution.

ADEC reviewed the CCS report (Roe et al., 2007) and identified GHG emission estimates of public interest that could be refined using ADEC's existing data. The AIRTOOLS Title V fuel data were used in ADEC's GHG inventory refinements to estimate GHG emissions for Alaska's major industrial sources. This is ADEC's first attempt to conduct a GHG EI for Alaska's major stationary sources. ADEC did not estimate greenhouse gas emissions from Alaska's minor stationary sources, transportation sources, agricultural sources and biogenic emissions (e.g. forest fires, methane released from tundra & taiga) in this inventory.

2.0 Methods

This section attempts to define terms, equations, methods, assumptions and quality assurance procedures used by ADEC to develop the GHG inventory of Title V stationary sources. The methods used in conducting this GHG EI were primarily derived from the Intergovernmental Panel on Climate Change's (IPCC's) 2006 Guidelines for National Greenhouse Gas Inventories, Volume 1, General Guidance and Reporting; and Volume 2, Energy (IPCC, 2006, www.ipcc-nggip.iges.or.jp/public/2006gl/index.htm).

2.1 Greenhouse Gas Emission Inventory

A greenhouse gas emission inventory will define pollutant and source types, source location, and emission volumes. The report will include a description of the methods and data sources used to prepare the estimates. By identifying source type, one can determine if emissions are dominated by a particular industry, process or activity. This allows for prioritization of controls when developing possible future control strategies. Estimating greenhouse gas emissions also allows ADEC to determine how Alaska's GHG contribution compares to other states and countries.

ADEC refinement of the CCS GHG EI covers major stationary sources (Title V permits) in Alaska for the year 2002. The greenhouse gases quantified in this report are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_20). Synthetic halocarbons (chlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, halons and sulphur hexafluoride) are not covered in this report but may be included in future GHG EI work for Alaska.

2.2 Emission Estimate Method

ADEC's method to estimate emissions follows the IPCC's TIER 1 guidelines. "The Tier 1 method is fuel-based, since greenhouse gas emissions from all sources of combustion can be estimated on the basis of the quantities of fuel combusted and average emission factors" (IPCC, 2006, Volume 2). This method combines information on fuel consumption, called activity data, with emission factors which quantify greenhouse gas emissions per unit fuel consumed (IPCC, 2006, Volume 2). Tier 1 emission factors are available for all relevant greenhouse gases. The basic equation is:

GHG Emissions ***($MMtCO_{2e}$)*** = Activity Data ***(Fuel Consumption)*** * Emission Factor
(AD) (EF)

Greenhouse gas emission totals for each Title V facility were quantified in million metric tons of CO_2 equivalents ($MMtCO_{2e}$). Activity data is the total amount of fuel (e.g. coal, gasoline, natural gas, diesel, etc.) consumed by each Title V facility. Emission factors are equivalent to the mass (usually in pounds) of carbon dioxide, methane or nitrous oxide emitted per unit of fuel consumed. The collection and use of activity data and emission factors are described in more detail below.

2.3 Title V Activity Data

All activity data or fuel data were obtained from the ADEC's AIRTOOLS database. Fuel data for each Title V facility in Alaska was downloaded from the AIRTOOLS database for the year 2002. Activity data is expressed in the amount of fuel consumed by each facility in gallons of diesel, distillate, oil, gasoline, liquid petroleum, jet naptha; tons of coal; or cubic feet of natural or process gas. Common terms and definitions of fuels are necessary for states and countries to consistently describe emissions from fuel combustion activities. The definitions for the various fuel types used in ADEC's Title V GHG EI were taken from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Energy, pages 1.12-16 (IPCC, 2006).

AIRTOOLS' Title V activity data includes fuels stored at Alaska's terminal port facilities and fuels transported in pipelines. For example, Title V activity data includes fuels stored at Tesoro Alaska Petroleum Company's Anchorage Terminals I & II and fuel transported in the Kenai Pipeline Facility. By calculating emissions for only those facility sources burning fuel on site, we can avoid the drawback of the CCS report where the emission calculations included all fuel sold, which may include fuel that is merely stored and transported. The CCS method may lead to an overestimate of the GHG EI results for any given facility or source. AIRTOOLS Title V activity data does not account for any greenhouse gas destruction, capture, storage, or sequestration that may occur during facility processes.

2.4 Title V Emission Factors

"An emission factor is a representative value that attempts to relate the quantity of a pollutant (e.g., greenhouse gases such as CO_2, CH_4, N_20) released to the atmosphere with an activity associated with the release of that pollutant (e.g., consumption of fossil fuels). These factors are usually expressed as the weight of pollutant divided by a unit weight or volume (e. g., pounds of CO_2 emitted per gallon of diesel burned or pounds of N_20 per ton of coal burned). Emission factors facilitate estimation of emissions from various sources of air pollution" (EPA, 1995).

The EPA and the U.S. Department of Energy's Energy Information Administration (EIA) provide emission factors for CO_2, CH_4, N_20 and other air pollutants based on the type of fuel burned and industrial process. ADEC obtained emission factors for each type of fuel burned at

all Title V facilities from EPA's AP-42 (EPA, 1995) and from the EIA website (see www.eia.doe.gov/oiaf/1605/coefficients.html).

Emission factors are available for every type of existing fuel and most industrial processes and are organized by Source Classification Codes (SCC). Examples of typical emission factors for burning of natural gas in a internal combustion engine with a gas turbine (SCC Code 20200201) are the following (EPA, 1995):

· 120 lbs. CO_2/1000 cu.ft. (120 pounds of CO_2 released per thousand cubic feet of gas burned)
· 0.0086 lbs. CH_4/1000 cu.ft
· 0.003 lbs. N_20/1000 cu.ft

2.4.1 Title V Weighted Emission Factors & Global Warming Potential

Individual emission factors for each greenhouse gas (CO_2, CH_4, N_20) can be multiplied by the amount of fuel consumed at an individual facility to calculate the amount (pounds) of an individual gas released. ADEC used a weighted emission factor, based on the global warming potential of each greenhouse gas, in order to convert individual greenhouse gas emissions into total greenhouse gas emissions in million metric tons of CO_2 equivalents ($MMtCO_{2e}$). The generally accepted authority on global warming potentials is the IPCC.

> "Global warming potentials (GWPs) are used to compare the abilities of different greenhouse gases to trap heat in the atmosphere. GWPs are based on the radiative efficiency (heat-absorbing ability) of each gas relative to that of carbon dioxide (CO_2), as well as the decay rate of each gas (the amount removed from the atmosphere over a given number of years) relative to that of CO_2. The GWP provides a construct for converting emissions of various gases into a common measure, which allows climate analysts to aggregate the radiative impacts of various greenhouse gases into a uniform measure denominated in carbon or carbon dioxide equivalents" (IPCC, 2001).

Global warming potentials for CO_2, CH_4, N_20 were obtained from the IPCC website (www.eia.doe.gov/oiaf/1605/gwp.html).

· Carbon Dioxide GWP=1
· Methane GWP= 23
· Nitrous Oxide GWP= 296

GWPs standardize the heat-absorbing ability of each greenhouse gas to carbon dioxide. Methane is 23 times more effective than carbon dioxide at trapping heat in the earth's atmosphere. Nitrous oxide is 296 times more effective than carbon dioxide at trapping heat in the earth's atmosphere. ADEC used GWPs to convert greenhouse gas emissions to $MMtCO_{2e}$ using the following equation:

$MMtCO_{2e}$ = Title V Fuel Consumption (AD) * Weighted EF

Where the Weighted EF = [CO_2EF + (23* CH_4EF) + (296* N_20EF)]

Using the example above, the burning of natural gas in an internal combustion engine with a gas turbine results in the following weighted emission factor:

Weighted EF = [CO_2EF + (23* CH_4EF) + (296* N_20EF)]

= [120 + (23* 0.0086) + (296 * 0.003)]

Weighted EF = 121.0858 pounds of CO_{2e} emitted per thousand cubic feet of gas burned

The weighted emission factor was then multiplied by the amount of fuel consumed at its respective Title V facility to calculate $MMtCO_{2e}$ emissions.

2.5 Title V GHG Emission Total (Example Calculation)

For further clarification, a sample calculation for estimating total greenhouse gas emissions, in $MMtCO_{2e}$, from an individual Title V facility is shown below. The following example is for an oil & gas platform which burns natural gas in an internal combustion engine with a gas turbine.

$MMtCO_{2e}$ = Title V Fuel Consumption *(*AD*)* * Weighted EF

$$= (217{,}123.2 \text{ thousand cubic feet natural gas}) * \frac{(121.0858 \text{ lbs.} CO_{2e})}{\text{thousand cubic feet}}$$

$$= (26{,}290{,}536.37 \text{ lbs. } CO_{2e}) * \frac{(\text{metric ton})}{(2204.6 \text{ lbs.})} * \frac{(\text{million metric ton})}{(1 \times 10^6 \text{ metric tons})}$$

= 0.011925 $MMtCO_{2e}$

Each Title V facility in Alaska can burn more than one type of fuel or burn the same type of fuel at multiple locations. For each Title V facility, total GHG emissions ($MMtCO_{2e}$) were calculated using the following formula (IPCC, 2006):

$$\text{Total Emissions } (MMtCO_{2e}) = \sum_{\text{fuels}} \text{Emissions } (MMtCO_{2e})_{,\ \text{fuel}}$$

For example, if in 2002 a Title V facility used a combination of diesel, natural gas and gasoline then the sum of their total emissions would be equal to:

$$\text{Total Emissions } (MMtCO_{2e}) = MMtCO_{2e,\ \text{diesel}} + MMtCO_{2e,\ \text{gas},} + MMtCO_{2e,\ \text{gasoline}}$$

2.6 Title V Stationary Source Groupings

The IPCC 2006 Guidelines assemble greenhouse emissions into five main sectors: 1) Energy; 2) Industrial Processes; 3) Agriculture, Forestry and Other Land Use; 4) Waste; 5) Other (IPCC, 2006, Volume 1). According to the IPCC, fuel combustion in stationary sources falls into the energy sector classification (IPCC, 2006, Volume 2).

> "The energy sector is mainly comprised of exploration and exploitation of primary energy sources; conversion of primary energy sources into more useable energy forms in refineries and power plants; transmission and distribution of fuels; use of fuels in stationary and mobile applications. The energy sector is usually the most important sector in greenhouse gas emission inventories, and typically contributes over 90 percent of the CO_2 emissions and 75 percent of the total greenhouse gas emissions in developed countries" (IPCC, 2006).

Within the IPCC energy sector there are multiple source categories (refer to IPCC, 2006 Guidelines, Volume 2, Energy, Tables 2.1 & 2.16). Source categories provide a mechanism for grouping individual emission sources and comparing GHG contributions between source types.

ADEC analyzed fuel combusted at Title V stationary sources. Under IPCC guidelines, combustion of fossil fuels at Title V facilities would be grouped into the energy sector. ADEC did not use the IPCC source categories. Instead, ADEC grouped individual Title V facilities into six categories: 1) Electricity Production; 2) Oil & Gas; 3) Seafood; 4) Military; 5) Municipal; 6) Other. These source categories are familiar to people living in Alaska and are representative of Alaska's major industries. The individual Title V companies and their estimated GHG emissions for 2002 are presented by ADEC source category in Section 3.0, Table 2.

ADEC also grouped the Title V GHG EI results by the same source categories used in the CCS GHG EI which they refer to as sector groupings (Table 1) (Roe et. al., 2007). This was done in order to compare ADEC and CCS results. ADEC grouped most Title V facilities into the CCS Industrial (non-fossil fuel[3]) category as presented in Section 3.0, Table 2. The individual Title V facilities and their estimated GHG emissions for 2002 are also presented by CCS source category in Section 3.0, Table 2.

2.7 Comparison of ADEC & CCS GHG EI Methods

A primary objective of this report included comparing the findings from the ADEC modifications to conclusions stated in the CCS GHG EI (Roe et al., 2007). In order to compare the results of the two efforts, it is necessary to know what methods were used by CCS, how these methods differed from ADEC, and how the results were categorized. This section provides a

[3] It is important to note that the CCS Industrial non-fossil fuel source category includes fuels consumed by the fossil fuel production industry during the exploration and acquisition of fossil fuels such as oil and gas. Therefore, most Title V facilities involved in the transportation, exploration and acquisition of oil and gas (e.g., BP Exploration, Conoco Phillips Alaska, Tesoro) can be grouped into the Industrial non-fossil fuel category.

brief description of the methods used by the CCS when conducting its GHG EI (Roe et al., 2007) for Alaska. The methods employed by CCS for conducting its GHG EI were taken from EPA's Emission Inventory Improvement Program "State Greenhouse Gas Inventory Tool (SGIT)", Chapters 1-14 (EPA, 2004).

Both the ADEC and CCS (Roe et al., 2007) GHG EI quantified carbon dioxide, methane and nitrous oxide released from fossil fuels combusted at stationary sources in Alaska. The literature sources used by the two inventories for fuel data, emission factors and GWP were different. The following sections describe the activity data and emission factors employed in the CCS GHG EI (Roe et al, 2007) to provide a basis for comparing the results and conclusions of the two inventories.

2.7.1 CCS GHG EI Activity Data

EPA's SGIT methods for estimating emissions of CO_2 from fossil fuels includes the following six steps: (1) obtain the required energy data; (2) estimate the total carbon content in fuels; (3) estimate the total carbon stored in products; (4) calculate net potential carbon emissions; (5) estimate the carbon oxidized from energy uses; and (6) convert net carbon emissions to units of metric tons of carbon equivalent (EPA, 2004).

The CCS GHG EI (Roe et al., 2007) used historical energy data (1990-2005) obtained from EIA's websites (http://tonto.eia.doe.gov/dnav/pet/pet_cons_prim_dcu_SAK_a.htm; and http://www.eia.doe.gov/emeu/states/state.html?q_state_a=co&q_state=ALASKA).

EIA fuel sales represent statewide fuel sales volumes for Alaska. These fuel statistics are less specific than the ADEC Title V fuel data. EIA fuel sales data are not facility specific and represent all of the fuel sold in Alaska including some fuels transported and combusted out of state. EIA groups fuel sales by the following consumers of fuel: residential, commercial, industrial, transportation and electric power (Table 1).

All of ADEC's fuel or activity data were obtained from ADEC's AIRTOOLS database and are specific for an individual Title V facility. Use of the AIRTOOLS database allowed ADEC to calculate GHG emissions only for those sources that combusted fuel at the facility. This is a significant difference with the CCS inventory whose calculations may have included fuel stored and transported by Alaskan industries.

2.7.2 CCS GHG EI Emission Factors & GWP

In the CCS GHG EI (Roe et al., 2007), EIA fuel sales data were converted to million British Thermal units (MMBtus) using the heat content of each fuel (see SGIT Chapter 1, Tables 1.4-2 and 1.4-3) (EPA, 2004). These data were multiplied by the appropriate carbon content coefficient (*lbs Carbon/MMBtu*) to estimate the total carbon content that could be released from fuels consumed in Alaska (SGIT Chapter 1, Tables 1.4-4 and 1.4-5) (EPA, 2004). Pounds of

carbon were then converted to $MMtCO_{2e}$. The CCS GHG EI (Roe et al., 2007) grouped emission estimates using the same source categories as listed in the EIA database (Table 1).

The CCS GHG EI (Roe et al., 2007) used different global warming potentials (GWP) and different emission factors than ADEC to estimate total greenhouse gas emissions. The CCS GHG EI employed 21 and 310 for the GWP of CH_4 or N_20, respectively. ADEC employed 23 and 296 for the GWP of CH_4 or N_20, respectively when calculating $MMtCO_{2e}$. Between the time CCS and ADEC conducted their inventories, the IPCC published new GWP for greenhouse gases explaining the difference in reported global warming potentials.

The CCS GHG EI employed the heat content and carbon content of fuels to estimate pounds of carbon emitted per million Btu of each type of fuel sold in Alaska. ADEC used EPA's AP-42 (EPA, 1995) and EIA emission factors specific for each fuel or industrial process to estimate $MMtCO_{2e}$ (EIA website). The emission factors used in the CCS GHG EI for CH_4 and N_20 were taken from the IPCC (IPCC, 1997). ADEC's GHG emission totals were also grouped by different sources as explained in Section 2.6.

The different fuel data, different GWP, different emission factors and different source groups employed in the ADEC and CCS GHG EI resulted in quantifiably different results. However, some of the conclusions reached by both the ADEC and CCS GHG EI are similar. The results of ADEC's GHG EI are presented and discussed in Section 3.0. Conclusions are presented in Section 4.0.

2.8 Data Quality Control & Quality Assurance

This section describes some of the quality control (QC) and quality assurance (QA) procedures used by ADEC during the development of the GHG EI to improve transparency, consistency, comparability, completeness, and accuracy.

2.8.1 Data Quality Control

A QA/QC plan was not developed by ADEC prior to data acquisition and analyses for the Title V GHG EI beyond basic guidelines to document data sources and double check calculations. The activity data and emission factors used in the ADEC Title V GHG EI data and calculations were compiled, analyzed, and performed by staff hired to conduct this effort. The documentation provided related to the inventory development effort included no specific written references for the emission factors used other then that they were obtained from EPA's AP-42 and the EIA website. All activity data were obtained from ADEC's AIRTOOLS database. Title V facility operating reports which populate the AIRTOOLS database are checked by ADEC staff for completeness and compliance with permit terms and conditions. Further, spot checks are performed on calculations.

2.8.2 Data Quality Assurance

The emission factors that were used by the ADEC staff person for the Title V GHG EI were reviewed by other staff in the ADEC's Division of Air Quality. Not all emission factors could be verified by their reference source for their applicability or accuracy. Most verified emission factors were found to be applicable; however, some emission factors were not accurate. The activity data was not checked internally by ADEC for accuracy or completeness. The calculations for estimating total GHG emissions were spot checked for accuracy and found to be correct.

3.0 Results

The results of ADEC's Title V GHG EI results are presented in Table 2. Alaska's Title V facilities for 2002 are presented by alphabetical order in Column 1. Greenhouse gas emission estimates ($MMtCO_{2e}$) for each company having a Title V permit in Alaska are presented in Column 2. The percentage contributions of each company's Title V facilities relative to the total GHG emission estimate for Title V sources in Alaska are presented in Column 3. Each company having a Title V permit was also grouped into one of the ADEC and CCS source categories as presented in Columns 4 and 5.

Table 2.Greenhouse Gas Emission Inventory Results for Title V Facilities 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)[4]
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 Assoc	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**	**100.00**	---	---

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

The individual companies with Title V permits were grouped by their respective ADEC source category and the total greenhouse gas emissions by category were summed as shown in Column 2, Table 3. Three companies (Agrium US Inc., Alaska Railroad Corporation and Capitol Disposal) that did not readily fit in the six specific categories were grouped into the "Other" source category. The percentages of greenhouse gas emissions for each source category were rounded to the nearest 1% and summed as shown in Column 3, Table 3. These percentages were then charted in Figure 1.

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	.017	1%
Municipal	.012	1%
Oil & Gas	15.26	73%
Other	1.76	8%
Seafood	0.16	1%
Totals	20.63	100%

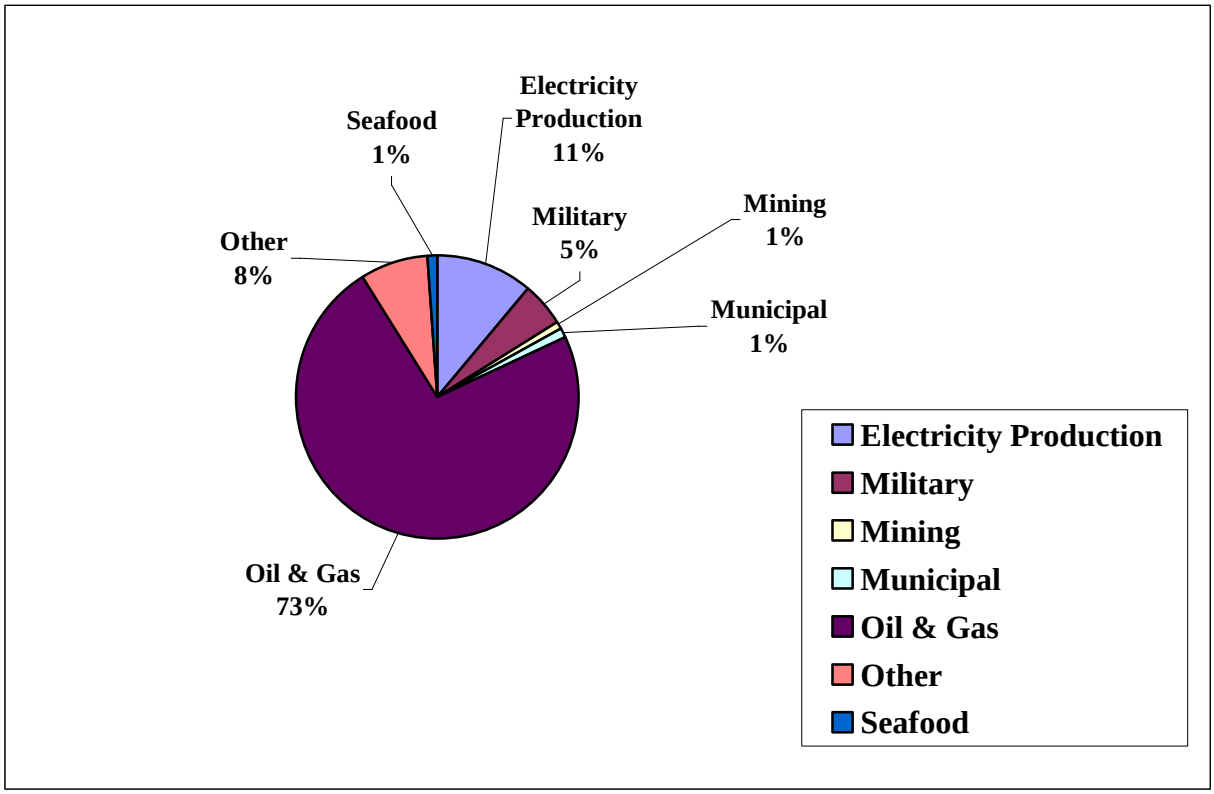

Figure 1. Title V GHG Emission Percentages by ADEC Source Category.

ADEC's Title V GHG EI results were also grouped using the CCS source categories taken from Table 2, Column 5. Grouping the ADEC Title V GHG EI results by CCS source group allows us to compare the results of both inventories. The total greenhouse gas emissions by CCS category were summed as shown in Column 2, Table 4. The percentages of greenhouse gas emissions for each source category were rounded to the nearest 1% and summed as shown in Column 3, Table 4. These percentages were charted in Figure 2.

Table 4. Title V GHG Emissions & Percentages by CCS Source Category.

CCS Source Category	**Total GHG Emissions** ($MMtCO_{2e}$)	**% of Total GHG Emissions**
Electricity Production	2.18	11%
Industrial (nnf)	18.30	88%
Residential/Commercial	0.15	1%
Totals	20.63	100%

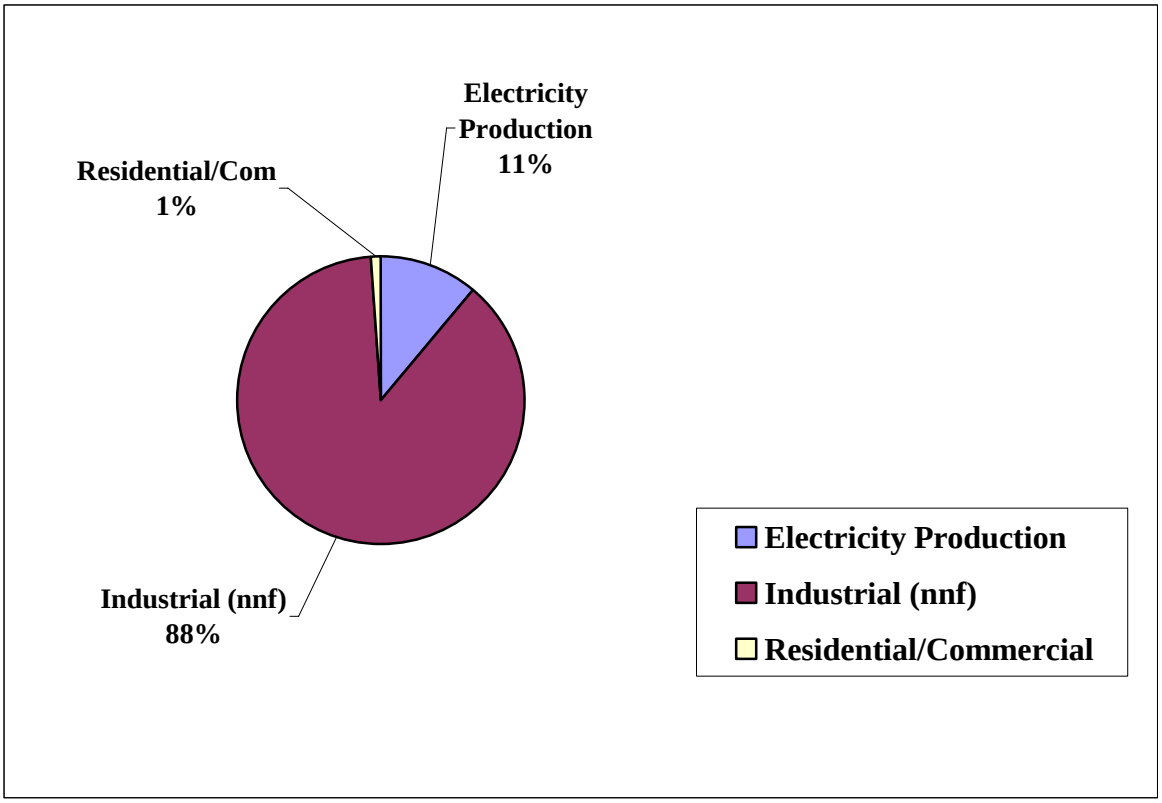

Figure 2. Title V GHG Emission Percentages by CCS Source Category.

3.1 Discussion of Title V GHG EI Results

The ADEC estimate for total greenhouse gas emissions for Title V facilities in Alaska for the year 2002 was found to be 20.625 $MMtCO_{2e}$ (Table 2). Again, these emission estimates are for CO_2, CH_4 and N_20 only. Some of the individual companies with permitted Title V sources that had the highest greenhouse gas emission estimates were BP Exploration (10.67 $MMtCO_{2e}$), Conoco Phillips (2.405 $MMtCO_{2e}$), Agrium US (1.737 $MMtCO_{2e}$), Chugach Electric Association (1.070 $MMtCO_{2e}$) and UNOCAL (0.746 $MMtCO_{2e}$).

The ADEC source categories (Table 3) contributing the highest percentage of the total greenhouse gas emissions were Oil & Gas (73%), Electricity Production (11%), Other (8%) and the Military (5%). Agrium US, Alaska Railroad Corporation and Capitol Disposal were grouped into the "Other" source category.

The Title V CCS source categories (Table 4) contributing the highest percentage of the total greenhouse gas emissions were industrial non-fossil fuels (88%) and electricity production (11%). Again, it is important to note that the CCS industrial non-fossil fuel source category includes fuels consumed by the industry during the transportation, storage, exploration and acquisition of fossil fuels. Therefore, most Title V facilities involved in the exploration and acquisition of oil and gas (e.g., BP Exploration, Conoco Phillips Alaska) were grouped into the industrial non-fossil fuel category. The fossil fuel production source group in the CCS report is defined by fugitive emissions (e.g. methane releases) that result from the extraction and refinement of fossil fuels, primarily coal and oil.

3.2 Comparing the ADEC and CCS GHG EI Results

The results of the ADEC Title V 2002 GHG EI and CCS GHG EI (Roe et al., 2007) are compared in Table 5 by year and source group. As shown in Table 5, the CCS GHG emission estimates for the years 2000 and 2005 (Table 1) (Roe et al., 2007) are greater than ADEC's Title V 2002 emission estimates for the three source groups (Table 4).

Table 5. Comparison of ADEC and CCS GHG EI Results by Source Category.

Reference & Year	Electricity Production	Industrial (nnf)	Residential/Commercial
(1)CCS, 2000	3.1 $MMtCO_{2e}$	19.6 $MMtCO_{2e}$	4.3 $MMtCO_{2e}$
ADEC, 2002	2.18 $MMtCO_{2e}$	18.3 $MMtCO_{2e}$	0.15 $MMtCO_{2e}$
(1)CCS, 2005	3.2 $MMtCO_{2e}$	21.6 $MMtCO_{2e}$	3.9 $MMtCO_{2e}$

Note (1): Center for Climate Strategies Reference is Roe et al., 2007.

The source group contributing the highest GHG emissions in both inventories was the industrial (non-fossil fuel) category which includes fuels stored, transported and consumed by the fossil fuel production industry and others during the transportation, storage, exploration and acquisition of fossil fuels. Unlike the CCS inventory, ADEC was able to distinguish between fuels consumed or combusted in-state versus fuels transported and consumed out-of-state. Further, ADEC did not estimate emissions for minor industrial sources included in the fuel consumption numbers used in the CCS inventory. This likely explains why ADEC estimates for industry are

slightly smaller than the CCS inventory. In either report however, those industries responsible for the acquisition, transportation and storage of fossil fuels (e.g. Conoco Phillips, BP Exploration, Tesoro Alaska Petroleum Company) had the higher emission estimates.

The differences between the ADEC and CCS GHG EI estimates are primarily due to the different literature sources used for fuel data, emission factors and GWP. Although the methodologies used by ADEC and CCS while conducting their respective GHG EI were somewhat different, the overall results were similar. The ADEC Title V and CCS GHG emission inventories:

· primarily used fuel data to estimate greenhouse gas emissions in Alaska.

· used different fuel data, different emission factors and different global warming potentials to estimate greenhouse gas emissions from stationary sources in Alaska.

· grouped the emission sources differently

· ADEC was able to distinguish between fuels combusted in Alaska and fuels transported and combusted elsewhere.

However, both emission inventories found that the industries in Alaska combusting, refining, storing and transporting the most fuel had the highest GHG emission estimates.

4.0 Conclusions

This section discusses some of the major findings of the ADEC Title V GHG EI with respect to the CCS GHG EI conclusions (Roe et al., 2007). Recommendations for possible future greenhouse gas emission inventory work in Alaska are also presented in this section.

4.1 Greenhouse Gas Emissions, Fossil Fuels & Carbon

Both the ADEC Title V and CCS GHG emission inventories found that those industries in Alaska combusting, refining, storing and transporting the most fossil fuel had the highest GHG emission estimates. Those industries in Alaska with the highest greenhouse gas emission estimates can be group into what the IPCC considers the “energy sector” (IPCC, 2006). Alaska’s energy sector includes those industries which rely on fossil fuels.

The CCS inventory coupled with ADEC’s Title V inventory refinements allows us to consider emission contributions by industry or source category. The inventories can help us identify and prioritize which emission sources should be addressed first and what technologies might be applied to control greenhouse gases before they are released into the atmosphere. The most current technologies for carbon dioxide capture and storage are presented in the IPCC Special and Technical reports (http://www.ipcc.ch/ipccreports/special-reports.htm) (IPCC, 2005). The CCS inventory based greenhouse gas emission estimates on historical and current fossil fuel reserves in Alaska with projections for future growth. Projections help determine impacts of

population growth and development on emissions and help determine effectiveness of future controls.

4.2 Future Climate Change Work by ADEC for Alaska

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. This section presents some recommendations for future GHG EI work for Alaska.

4.2.1 Develop Detailed Greenhouse Gas Emission Inventory for Alaska

If future policy determines a need for more refined emission estimates ADEC may initiate development of a more detailed GHG EI for Alaska. This work may include developing a standardized 'Greenhouse Gas Emissions Inventory Protocol' for Alaska. ADEC may create or adopt a standardized protocol for conducting GHG EI that would be open for comment from EPA, industry stakeholders and the public. The methods for conducting the GHG EI would be standardized and open to public comment to provide consistency and transparency so that the industry and the public know where the data came from and how it was analyzed. Future GHG EI work could include providing emission estimates for all IPCC sectors in Alaska.

4.2.2 Greenhouse Gas Emissions from Non-Title V Industrial Sources

During 2007, ADEC developed emission estimates for the largest industrial facilities, those that require a Title V operating permit. These large sources are not the only industrial facilities operating within the state. Other smaller facilities operate, many under pre-approved emission limit permits, general permits, minor permits, or owner requested limit permits. ADEC staff began work to characterize the GHG emissions from these sources, but did not have complete data to calculate their total contribution to GHG emissions. Additional data and work is needed to define their contribution to the overall emissions with any certainty.

4.2.3 Greenhouse Gas Emission Projection Scenarios

In the CCS report, reference case emission projections are included for 2010 and 2020. These projections are a starting point for looking at future emission impacts, but emission projections could be made for many future scenarios. To aid in development of climate change policies, ADEC may need to develop future emission estimates based on specific scenarios of interest. These emission projections would need to be based on a transparent set of assumptions and well documented to support the needs of policy makers.

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