Alaska Climate Change Strategy
Mitigation Advisory Group
Executive Summary

Important Introductory Note

The Mitigation Advisory Group (MAG) was tasked by the Alaska Climate Change Sub-cabinet with preparing recommendations on measures that might be included in a strategy to mitigate (i.e. reduce) greenhouse gas emissions in Alaska. It was ~~also~~ not within the scope of the MAG's charge to evaluate what effect any recommended measure, if developed and implemented in Alaska, might have on climate in Alaska. The MAG was not asked to, and did not, take any position on the extent or causes of climate change in Alaska.

This report ~~is report c~~contains a range of potential mitigation measures identified by the ~~Alaska Mitigation Advisory Group~~ (MAG~~)~~. These include measures the MAG believes need more analysis and development before they should be considered for implementation. If ultimately included in the Alaska Climate Change Strategy recommended by the Governor's Climate Change Sub-Cabinet, these measures should be identified as options for further study only.

This report also describes measures where the benefits and feasibility of implementation are more certain. These may require much less analysis or development before they could be considered for implementation. A similar short boxed statement appears at the beginning of the "Oil and Gas" and "Energy, Supply and Demand" sections of the report identifying those measures – or "recommendations" as they are called in the report – that clearly fall in the "options for further study" side of this continuum.

Regardless, the MAG believes no "recommendation" discussed in this report should be included in the set of recommendations provided by the Sub-Cabinet to the Governor for his consideration without first evaluating the economic impacts that adoption of the recommendation would have in Alaska. It was not within the scope of the MAG's charge to fully quantify the macro-economic costs or benefits of any recommendations that might be developed and eventually implemented to reduce greenhouse gas emissions from sources within Alaska.

~~The Alaska Climate Change Mitigation Advisory Group (MAG), convened by the Alaska Climate Change Sub-Cabinet, is pleased to present this assessment and set of recommendations to mitigate the state's emissions of greenhouse gases for the Sub-Cabinet's consideration and further analysis. Although Alaska's greenhouse gas (GHG) emissions constitute only 0.7% of U.S. GHG emissions, climate change has affected both Alaska and the entire Arctic region much~~

~~more profoundly and rapidly than other regions of the world. Accordingly, actions by Alaska will help the rest of the nation and the global community with definitive, effective measures to mitigate the deleterious economic, social, cultural and environmental impacts of a disrupted climate and help ensure a more sustainable world for future generations.~~

On September 14, 2007, Governor Sarah Palin signed Administrative Order 238[1], which established the Alaska Climate Change Sub-Cabinet and tasked it with preparing Alaska's Climate Change Strategy. A warming climate is having serious and broad-scale impacts in Alaska, including flooding of villages; increasingly strong coastal storms, eroding the beaches of coastal villages; subsidence from thawing of permafrost; and a record number of forest fires threatening communities, property, and air quality. The comprehensive Alaska Climate Change Strategy describes the actual and foreseeable effects of climate warming in Alaska[2,3], recommends appropriate measures and policies to prepare communities for responding to them, and provides guidance regarding Alaska's participation in regional and national responses to climate change.

The Sub-Cabinet formed two Work Groups to address Alaska's immediate and research needs, and two Advisory Groups to focus on reducing GHG emissions ~~climate~~ (mitigation) and preparing for a changing climate (adaptation) in the state. This report details the processes, analyses, and recommendations of the diverse group of 26 members of the MAG to reduce Alaska's GHG emissions, such as the expanded use of energy conservation and efficiency, renewable energy and fuels, land-use management, and transportation planning. The MAG was not tasked with a review of the underlying science of GHG emissions and did not address this in its deliberations. The MAG recognizes that the Sub-Cabinet will undertake further review, input, and analysis of these options before making its final recommendations to the Governor's Office.

Sector-specific Technical Work Groups (TWGs), comprised of subject-matter experts, advised the MAG in each of the following areas: Cross-Cutting Issues; Energy Supply and Demand; Forestry, Agriculture, and Waste Management; Oil and Gas; and Transportation and Land Use.

Alaska's Department of Environmental Conservation (DEC) provided the overall leadership of the effort and substantive support. The Center for Climate Strategies (CCS), a nonpartisan, nonprofit organization guided the process, facilitating the MAG and most TWG meetings and conference calls with the capable assistance of two local Alaskan facilitators and provided technical expertise for quantification of the costs and benefits of the policy recommendations.

The MAG recommends 32 policies for the Sub-Cabinet's consideration and further analysis. Specifically, the MAG is recommending these options as potentially the best methods to reduce GHG emissions~~address climate change mitigation~~ in Alaska. The MAG is not recommending implementation of these actions without further study, input and analysis.

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[1] This report, Appendix A. Administrative Order 238 Establishing the Alaska Climate Change Sub-Cabinet,

[2] Immediate Action Workgroup: Recommendations to the Governor's Sub-Cabinet on Climate Change, March 2009. 168 pages. http://www.climatechange.alaska.gov/docs/iaw_finalrpt_12mar09.pdf

[3] Adaptation Advisory Group: Recommendations to the Governor's Sub-Cabinet on Climate Change, in publication, 2009. http://www.climatechange.alaska.gov

On a strict cost basis, some recommendations currently are too expensive to implement, however, others argue that the societal costs from climate change and the cost of inaction is estimated to be quite high if climate change continues its current trajectory unabated.[4] Without attributing the cause of climate change, a~~A~~ University of Alaska Anchorage study estimated ~~finds~~ that climate change could add $3.6–$6.1 billion (+10% to +20% above normal wear and tear) to future costs for public infrastructure from now to 2030 and $5.6–$7.6 billion (+10% to +12%) from now to 2080.[5] Alaska's GHG emissions constitute about 0.7% of U.S. GHG emissions.

Many of these policies are quantified in terms of potential GHG emissions reduced and direct costs or savings. An overview of the MAG's work, by sector, can be found in the report's chapters, and detailed analyses of the recommended policy options are presented in the appendices. The MAG approved 30 of the 32 options unanimously; objections are noted. The estimated efficacy of these policies can be compared against the Alaska GHG Inventory and Forecast[6] (I&F) that was prepared prior to, and updated throughout, the MAG process.

One action is recommended to be placed on hold awaiting outcome of federal action. One action (not included in the total above) is not currently recommended because cost-effective technology essential to implementation does not exist.

Inventory of Alaska's Greenhouse Gas Emissions

CCS initially prepared a comprehensive draft I&F of emissions in 2007 for the Alaska DEC. The report presented an assessment of the state's GHG emissions and sinks (carbon storage) from 1990 to 2020. In 2009, the forecast was updated and extended to 2025. The draft I&F provided an initial comprehensive understanding of Alaska's actual and potential GHG emissions, and thereby informed the identification and analysis of policy options for mitigating GHG emissions. The MAG and ~~a number of~~ the TWGs ~~have~~ were asked to reviewe~~d~~, discusse~~d~~, evaluate~~d~~ and revise~~d~~ specific portions of the draft inventory pertaining to their sectors, as well as alternative data and approaches. No review of methodology or forecasting was performed by the MAG or TWGs. Those revisions have been incorporated in this report.

Emissions and Reference Case Projections (Business as Usual)

Alaska's anthropogenic (human-caused) GHG emissions and sinks were estimated for the period 1990–2025. Historical GHG emission estimates (1990–2005) were developed from the best data available. The reference case emission projections (2006–2025) are based on a compilation of various existing projections of fuel use, electricity generation, and other GHG-emitting activities for Alaska, along with a set of transparent assumptions described in the appendices of this report.

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[4] Stern, Sir Nicholas, et.al, *Stern Review: The Economics of Climate Change*, for the Prime Minister of the United Kingdom, 2007. http://webarchive.nationalarchives.gov.uk/

[5] Larsen,P.,S. Goldsmith, O.Smith, M. Wilson, K Stzepek, P. Chinowski, and B. Saylor, *Estimating the Future Costs of Alaska Public Infrastructure at Risk from Climate Change.* Univeristy of Alaska Anchorage. 2007 http://www.sciencedirect.com

[6] Center for Climate Strategies. *Final Alaska Greenhouse Gas Inventory and Reference Case Projections: 1990–2025*. Prepared for the Alaska Climate Change Mitigation Advisory Group, July 2009, available at http://www.akclimatechange.us/Inventory_Forecast_Report.cfm and attached as Appendix D of this report.

The I&F covers the six types of gases included in the U.S. Greenhouse Gas Inventory[7]: carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Emissions of these GHGs are presented using a common metric, CO_2 equivalence, which indicates the relative contribution of each gas to atmospheric change as compared to CO_2.

Activities in Alaska accounted for approximately 50.6 million metric tons[8] of carbon dioxide equivalent ($MMtCO_2e$) emissions in 2005, an amount equal to about 0.7% of total U.S. gross GHG emissions.[9] Estimates of carbon sinks, i.e., CO_2 sequestered in Alaska's managed forests[10], are -1.4 $MMtCO_2$/year. This leads to net emissions of 49.2 $MMtCO_2e$ in Alaska in 2005. Table EX-1 summarizes these figures.

Table EX-1. Summary of Alaska historical and projected gross and GHG net emissions, 1990–2025 ($MMtCO_2e$)

Types of Emissions	1990	2000	2005	2010	2020	2025
Total Gross Emissions	**39.0**	**46.1**	**50.6**	**53.5**	**60.3**	**62.8**
Increase over 1990		*18%*	*30%*	*37%*	*55%*	*61%*
Forest Carbon Sinks	–0.3	–1.4	–1.4	–1.4	–1.4	–1.4
Total Net Emissions	**38.7**	**44.7**	**49.2**	**52.1**	**58.9**	**61.4**
Increase over 1990		*15%*	*27%*	*35%*	*52%*	*59%*

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Alaska's gross GHG emissions grew at a faster rate than those of the nation as a whole. From 1990 to 2005, Alaska's gross GHG emissions increased by 30%, while national emissions rose by 16%.

Gross emissions by sector, both historical and projected under a business-as-usual (BAU) scenario, are illustrated in Figures EX-1 and EX-2. A consumption-based model is used, as opposed to a production-based model. This means that only emissions related to products purchased or obtained within Alaska are included, with the exception of oil and gas, as opposed to emissions from producing a product that is consumed outside the state. One particularly challenging aspect has been to segregate aviation fuel purchased for aircraft that are using Alaska's airports for refueling stops en route to out-of-state destinations.[11] Approximately 31% of the aviation GHG emissions associated with jet fuel sold in Alaska is for refueling aircraft unrelated to the Alaskan transport or freight.

[7] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*, EPA 430-R-08-005, April 15, 2008. Available at: http://epa.gov/climatechange/emissions/usinventoryreport.html.

[8] One metric ton is equivalent to 2,200 pounds.

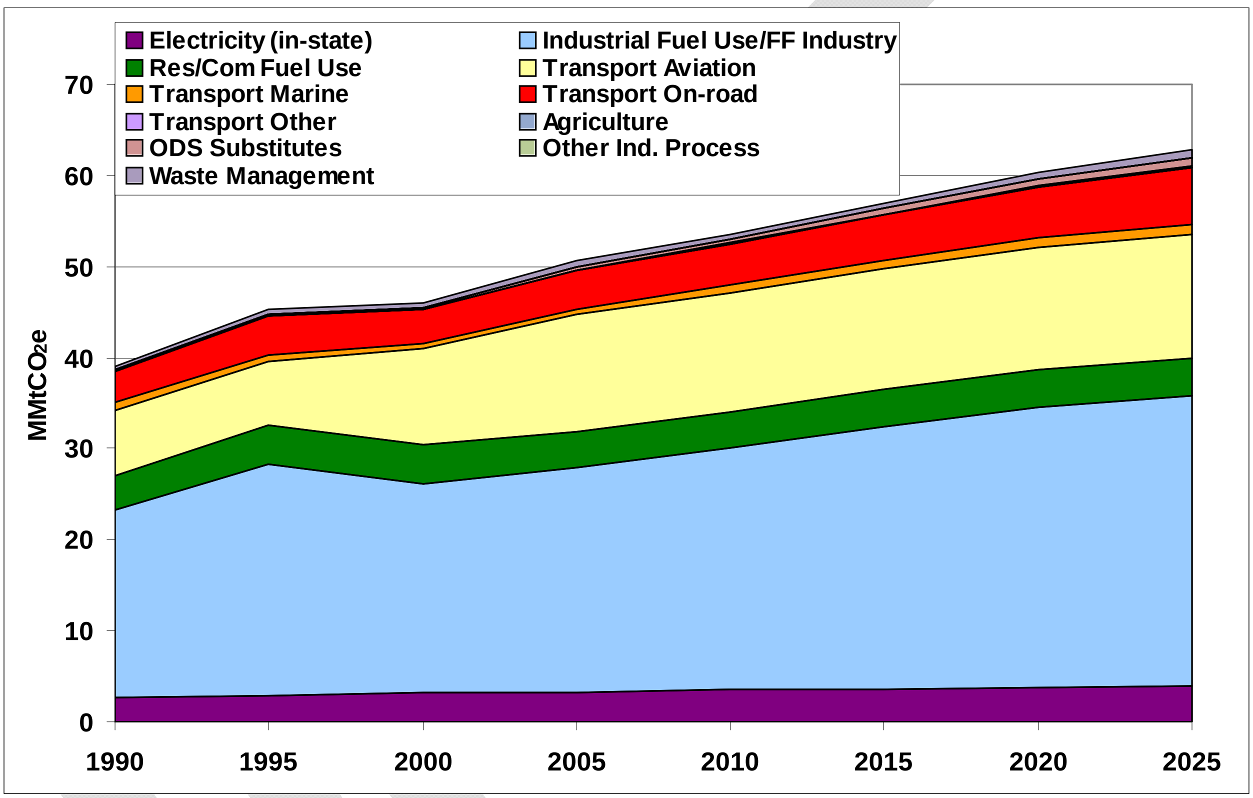
[9] Gross emissions exclude carbon sinks, such as forests, which absorb carbon dioxide and result in lower net GHG emissions.

[10] Managed forests reference coastal maritime forests in Alaska. See Appendix H: Forestry, Agriculture, and Waste Management Sectors. As described in the appendix, Alaska's boreal forests are not considered managed forests; hence, they are not included in this table (as they are considered a natural source). If the boreal forest was to be included as an anthropogenic source (a managed forest), the overall impacts to the state's I&F would be tremendous: the net sink of 1.4 $MMtCO_2$ would convert to a net source of over 40 $MMtCO_2$ annually due in large part to carbon losses from wildfires.

[11] See Chapter 7: Transportation and Land Use Sectors and Appendix J: Transportation and Land Use Policy Recommendations.

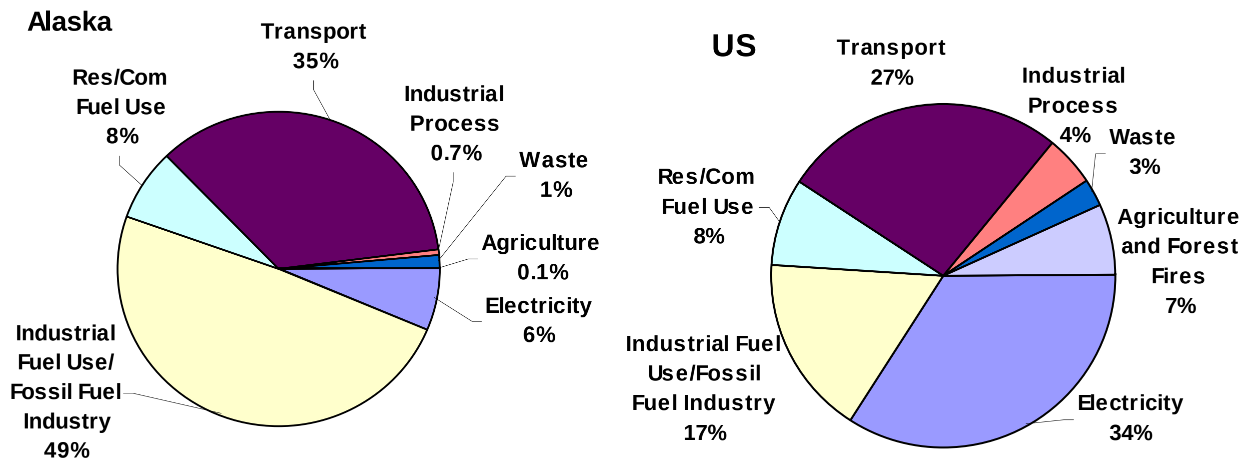
The principal source of Alaska's GHG emissions is the industrial sector, accounting for 49% of total state gross GHG emissions in 2005. The industrial sector includes direct fossil fuel combustion at industrial sites as well as fossil fuel industry emissions associated with oil and natural gas production, processing, transmission and distribution, flaring, fugitive methane from leaks and venting, and pipeline fuel use, as well as with oil production and refining and coal mining emission releases. The next-largest contributor to total gross GHG emissions is the transportation sector, which accounted for 35% of the total Alaska gross GHG emissions in 2005.

Figure EX-1. Gross Alaska GHG emissions by sector, 1990–2025: historical and projected



GHG = greenhouse gas; MMtCO_2e = million metric tons of carbon dioxide equivalent; FF=fossil fuel; Res/Com = direct fuel use in the residential and commercial sectors; ODS = ozone-depleting substance. Gross emissions exclude forest carbon sinks and natural sources (forest carbon losses in the boreal forest).

Figure EX-2. 2005 Alaska emissions by sector



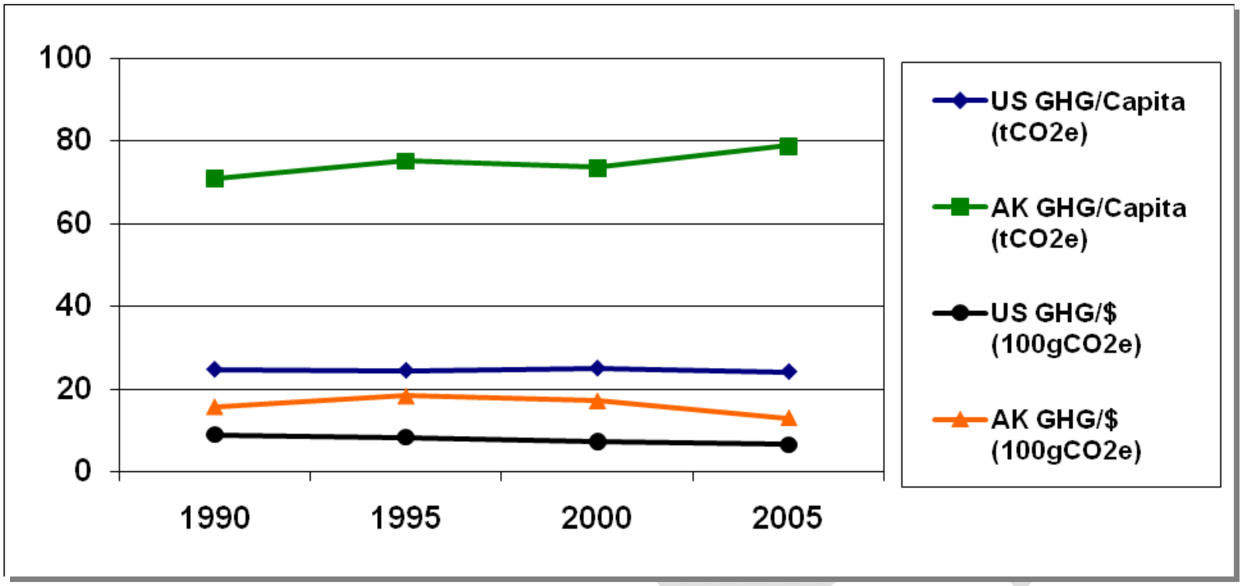
Notes: Res/Com = Residential and commercial fuel use sectors.

Emissions from the residential and commercial fuel use sectors are associated with the direct use of fuels (natural gas, petroleum, coal, and wood) to provide space heating, water heating, process heating, cooking, and other energy end uses. The commercial sector accounts for emissions associated with the direct use of fuels by, for example, hospitals, schools, government buildings (local, county, and state), and other commercial establishments. The industrial fuel use/fossil fuel industry sector accounts for direct fuel combustion in the industrial sector as well as fugitive methane that occurs from leaks and venting during the production, processing, transmission, and distribution of fossil fuels. The industrial processes sector accounts for emissions associated with manufacturing and excludes emissions included in the industrial fuel use/fossil fuel industry sector. The transportation sector accounts for emissions associated with fuel consumption by all on-road and non-highway vehicles. Non-highway vehicles include jet aircraft, gasoline-fueled piston aircraft, railway locomotives, boats, and ships. Emissions from non-highway agricultural and construction equipment are included in the industrial sector. Electricity = Electricity generation sector emissions on a consumption basis. In Alaska, the electricity consumed is assumed to be the same as the electricity produced in the state.

On a per capita basis, Alaskans emitted about 79 metric tons (t) of CO_2e in 2005, higher than the national average of 24 tCO_2e in 2005 and higher than any other state (Figure EX-3). The higher per-capita emission rates in Alaska are driven by emissions from the industrial fuel combustion and transportation sectors, which are much higher than the national average. Major contributing factors to a higher per capita emissions include: Alaska is a major exporter of energy, requiring significant emissions to produce; greater distances for travel and transport; high levels of air traffic, including refueling stops for pass-through flights; long periods of low light and extremely cold temperatures; and overall low population.

During 1990–2005, per-capita emissions in Alaska increased slightly; economic growth exceeded emissions growth, leading to declining estimates of GHG emissions per unit of state product. Emissions per unit of gross product dropped by 26% nationally and by 17% in Alaska. (See bottom two lines of Figure EX-3)

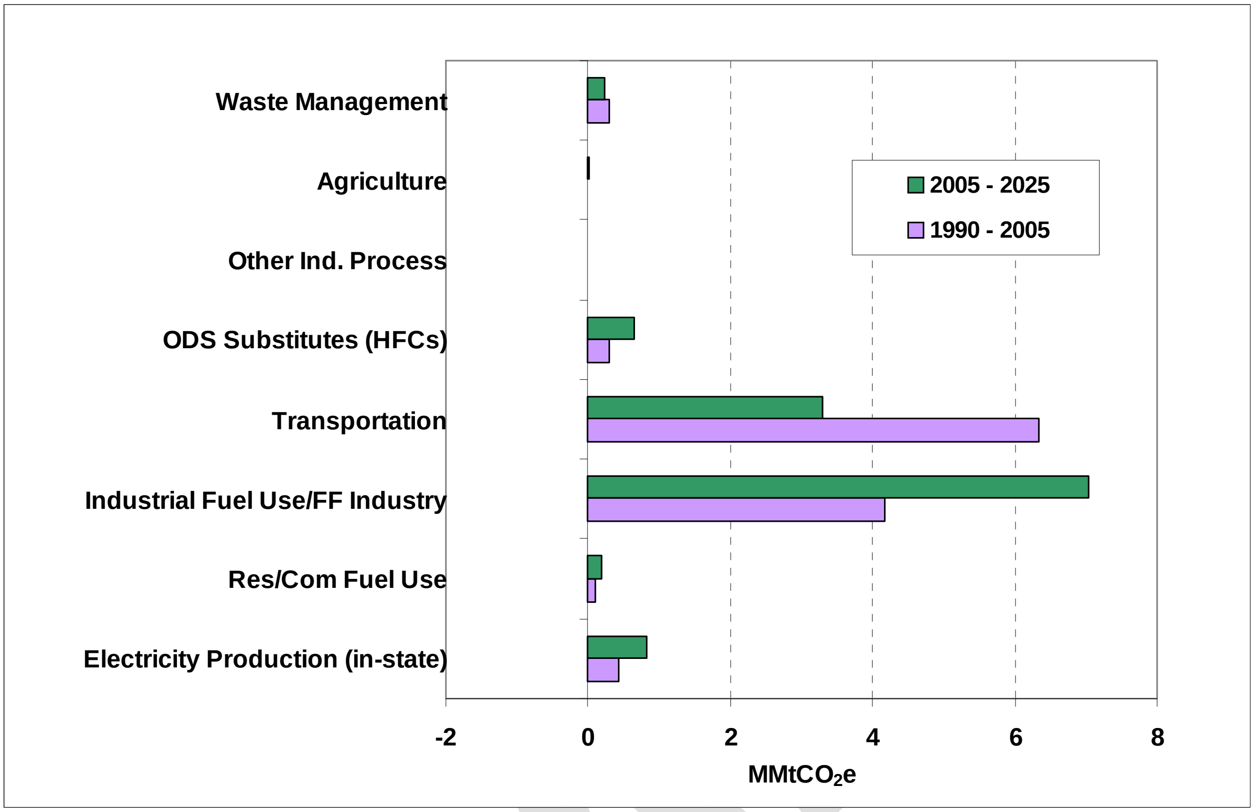
Figure EX-3. Comparison of U.S. and Alaska GHG emissions, per capita and per-unit gross product



AK = Alaska; CO_2e = carbon dioxide equivalent; g = gram; GHG = greenhouse gas; tCO_2e = metric tons of carbon dioxide equivalent.

Alaska's gross GHG emissions are projected to climb to 62.8 $MMtCO_2e$ per year by 2025—61% above 1990 levels. Historical and projected GHG emissions by sector are displayed in Figure EX-4. As shown in Figure EX-4, emissions associated with industrial fuel use are projected to be the largest contributor to future emissions growth., followed by e Emissions from the transportation sector, despite an overall reduction in transportation emissions from 2005 to 2025, are projected to continue to be the next largest contributor to gross GHG emissions.

Figure EX-4. Historical and projected emissions by sector



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; Ind. = industrial; ODS = ozone-depleting substance; HFCs = hydrofluorocarbons; FF= fossil fuel; Res/Com = residential and commercial sectors.

Some data gaps exist in this analysis, particularly for the reference case projections. Emissions of aerosols, which include volcanic dust and particulate matter from forest fires and fossil fuel combustion, could have significant climate impacts through their effects on radiative forcing.[12] The degree to which any of these aerosol sources play a net positive or negative effect on radiative forcing depends on their chemical make-up. A key determinant is the ratio of organic carbon to black carbon. Aerosols with a lower ratio will have a net positive effect (i.e. a global warming effect). The primary sources of these aerosols are fossil fuel combustion (diesel fuel, coal, residual oil). Aerosols from forest fires have a very high organic carbon to black carbon ratio, which produce a net negative climate forcing effect. On a CO_2-equivalent basis, the total estimated black carbon emissions for 2002 in Alaska were 3.0 $MMtCO_2e$. It is estimated that black carbon emissions will decrease by 2018 after new engine and fuel standards take effect. These estimates are not incorporated into the Alaska reference case projections because a global warming potential for black carbon has not yet been assigned by the Intergovernmental Panel on Climate Change.

[12] Change in the radiation balance between the energy absorbed by the Earth and that, which is radiated back into space. Particulate matter in the atmosphere can absorb or reflect energy. Radiative forcing estimates for the different types aerosol species are available from the Intergovernmental Panel on Climate Change; however, global warming potentials have not been set. See Appendix H of the AK Inventory & Forecast Report for a discussion of the black carbon inventory and forecast and Appendix I of that report for more discussion on the climate forcing of aerosols.

Primary tasks for future GHG inventory work in Alaska include review and revision of key emissions drivers. These are most notably electricity, fossil fuel production, transportation fuel use growth rates, and future electricity generation source mix, which will be major determinants of Alaska's future GHG emissions.

Appendix D, Alaska Greenhouse Gas Inventory and Reference Case Projections, provides detailed background information on GHGs and climate-forcing aerosols.

Recent Climate Change Mitigation Actions

The federal Energy Independence and Security Act of 2007 was signed into law in December 2007, requiring actions that will reduce GHG emissions over the next few years. GHG emission reductions associated with implementing the Corporate Average Fuel Economy (CAFE) requirements in Alaska were quantified. The MAG also identified recent actions that Alaska has undertaken to control GHG emissions and conserve energy. A weatherization bonding program reduces emissions relative to the overall BAU reference case projections slightly. This program is only funded from 2010 to 2014, and would account for a reduction of about 0.07 $MMtCO_2e$ in 2010. Future reductions were not quantified, as it cannot be assumed that the program will continue beyond 2014.

Table EX-2 summarizes the GHG emission reductions projected to be achieved by these recent actions. This table shows a total reduction of about 0.7 $MMtCO_2e$ in 2025 from the BAU reference case emissions, or a 1.2% reduction from the BAU emissions in 2025 for all sectors combined.

Table EX-2. Emission reduction estimates associated with the effect of recent actions in Alaska (consumption-based, gross emissions)

Sector/Recent Action	GHG Reductions ($MMtCO_2e$)		GHG Emissions ($MMtCO_2e$)	
			Business as Usual	With Recent Actions
	2015	2025	2025	2025
Residential/Commercial/Industrial (RCI) Fuel Use				
Weatherization Bonding	0	0	33.9	33.9
Transportation and Land Use (TLU)				
Federal Corporate Average Fuel Economy (CAFE) Requirements	0.22	0.73	21.1	20.4
Total (RCI + TLU Sectors)			**55**	**54.3**
Alaska Total (All Sectors)			**62.8**	**62.1**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Alaska Climate Change Strategy Mitigation Advisory Group Recommendations

Along with the data from the I&F, individual members of the MAG contributed insights, observation, experience, and data from their particular field of expertise. These, combined with presentations from scientists, agency personnel, and practitioners in the fields of climate change and energy policy, fortified the MAG and TWGs while they deliberated over actions most likely to effectively reduce GHG emissions in Alaska.

The MAG and TWGs began with a catalog of over 350 potential actions and policies that could be adopted to mitigate climate change. This catalog was compiled by CCS based on its extensive experience in over 25 other states and regions. Alaskans involved in the MAG and TWG processes carefully weighed, combined, customized, and prioritized the actions that seemed most viable for the state. Through iterative processes and joint deliberation, 32 options, somewhat evenly distributed in number by sector, were identified for further study.

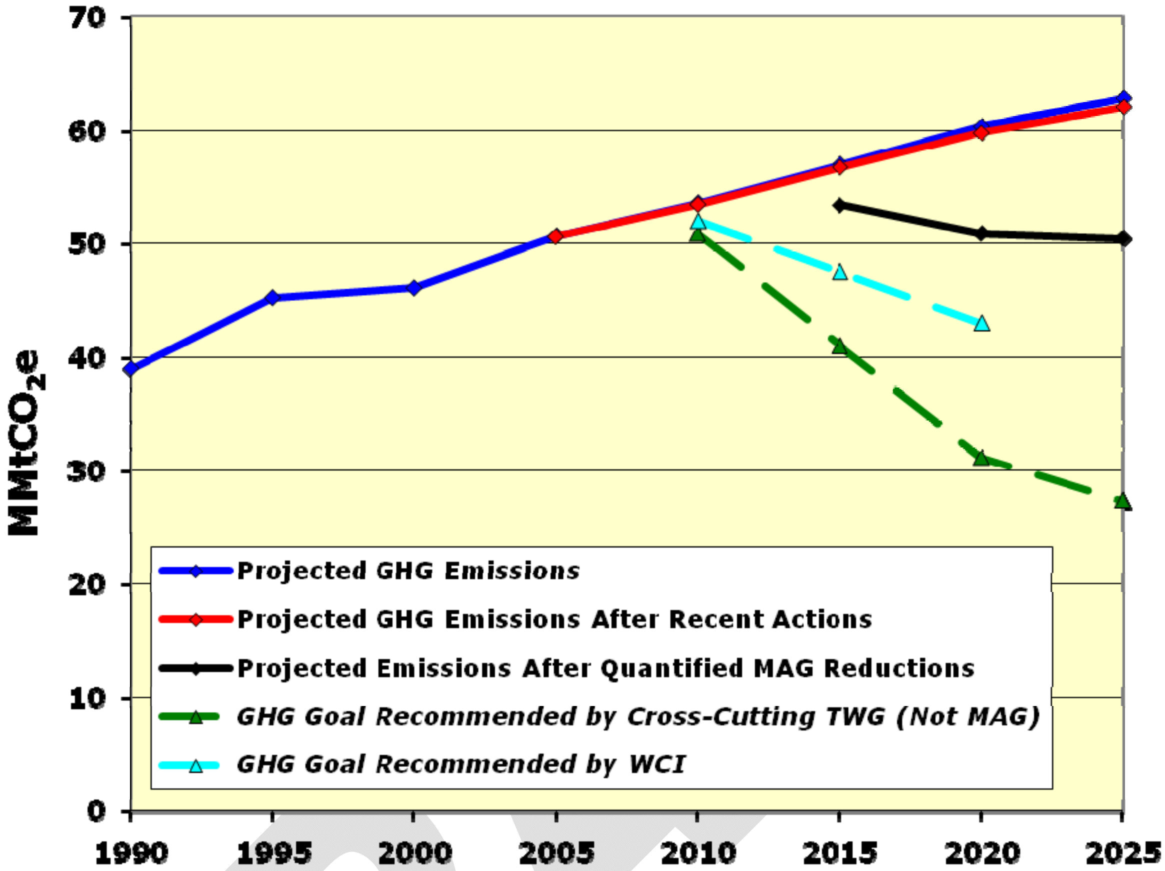
Participants developed comprehensive descriptions and designs of the policy options. They then identified potential goals and implementation measures for each, noting any related programs or policies in place or pending implementation. Parties whose involvement would be necessary were also identified. Policies that were quantifiable were carefully evaluated by CCS's ~~or ICF's~~ technical experts for reductions in GHG emissions and associated direct costs. These quantifications were reviewed, revised where necessary, and approved by the MAG. The results for each sector are displayed later in this Executive Summary and are discussed in detail in the report's chapters and appendices.

Cumulatively, if all quantified actions were implemented, there would be a reduction in GHGs from 62.1 to 50.4 $MMtCO_2e$ by 2025. This is 11.7 $MMtCO_2e$ below the BAU projection if no actions other than federal CAFE standards were implemented. Figure EX-5 illustrates the projected results from different reduction strategies. Figure EX-5b illustrates the projected results after removing emissions from aviation refueling unrelated to Alaska activities and beyond the state's control from the baseline BAU. If all quantified actions were implemented, the BAU GHG emissions without transient aviation refueling would be reduced from 58.5 to 46.8 $MMtCO_2e$ by 2025.

The lowest line on these graphs illustrates the reduction target that the Cross-Cutting Issues (CC) TWG recommended that the Sub-Cabinet consider as a statewide goal.[13] This represents reductions of 20% below 1990 GHG emissions levels by 2020, and 80% below 1990 levels by 2050. For comparison purposes, the recommended emission reduction goal from the Western Climate Initiative (WCI) is also shown on each. WCI is comprised of seven western states and four Canadian provinces as members; seven other U.S. states and six Mexican states are observers. Alaska is an observer state.

[13] See Chapter 3: Cross-Cutting Issues and Appendix F: Cross-Cutting Issues Policy Recommendations.

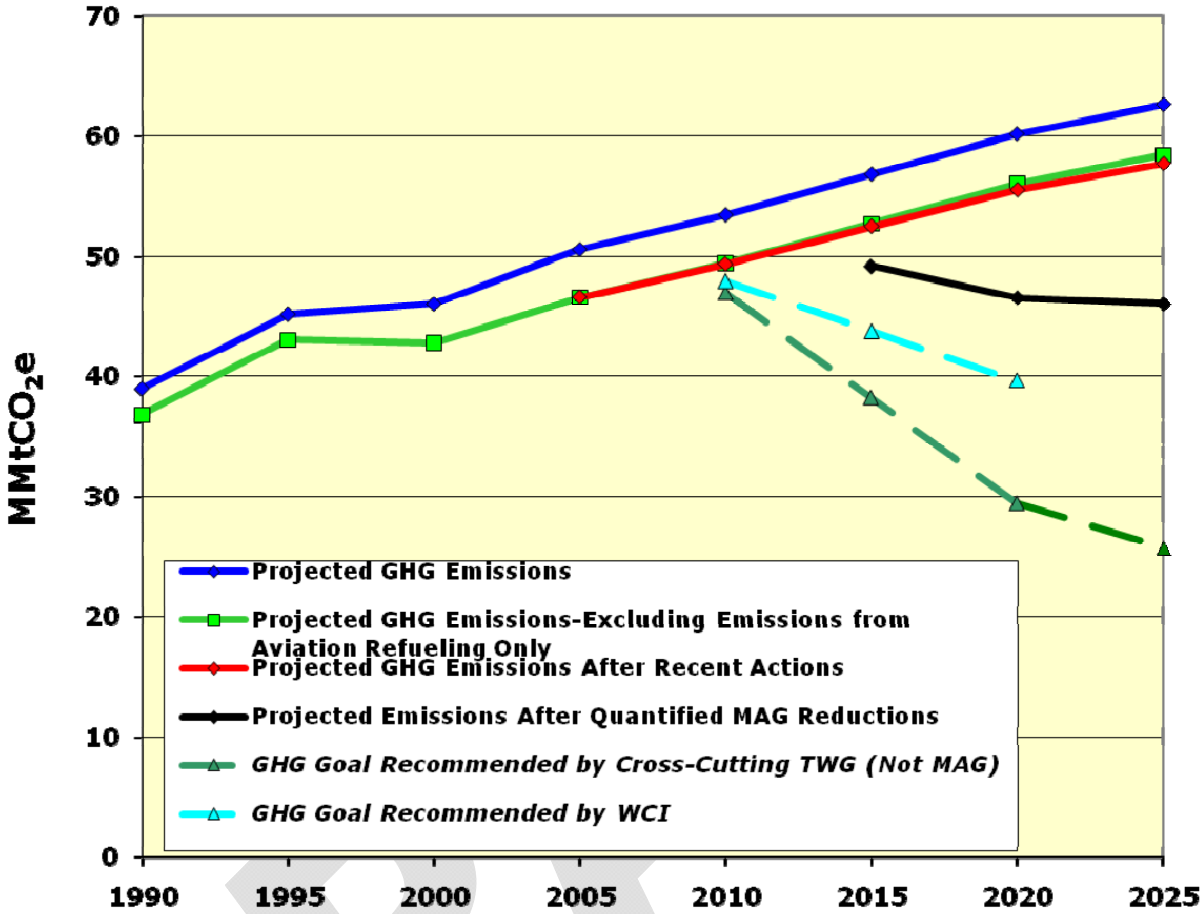
Figure EX-5a. Projected Alaska GHG emission scenarios: historical to 2025 (consumption-based, gross emissions)



GHG = greenhouse gas; MAG = Mitigation Advisory Group. $MMtCO_2e$ = million metric tons of carbon dioxide equivalents; TWG = Technical Work Group; WCI = Western Climate Initiative.

As is evident on both EX-5a and EX-5b, the quantified options recommended in this report are not sufficient to reach tentative goals. Unquantified options, such as conservation and state government leading-by-example, will reduce emissions further. Other emission-reducing actions beyond the scope of this report are anticipated. In particular, actions that save money and energy will be very advantageous for a broad range of individuals and businesses to implement independent of recommendations from the Sub-Cabinet. For example, a MAG member from an aviation-dependent delivery corporation outlined the aggressive sustainability measures implemented by the company that not only save money and fuel but also reduce GHG emissions.

Figure EX-5b. Projected Alaska GHG emission scenarios: historical to 2025 (consumption-based, gross emissions excluding refueling transient aircraft)



GHG = greenhouse gas; MAG = Mitigation Advisory Group. $MMtCO_2e$ = million metric tons of carbon dioxide equivalents; TWG = Technical Work Group; WCI = Western Climate Initiative.

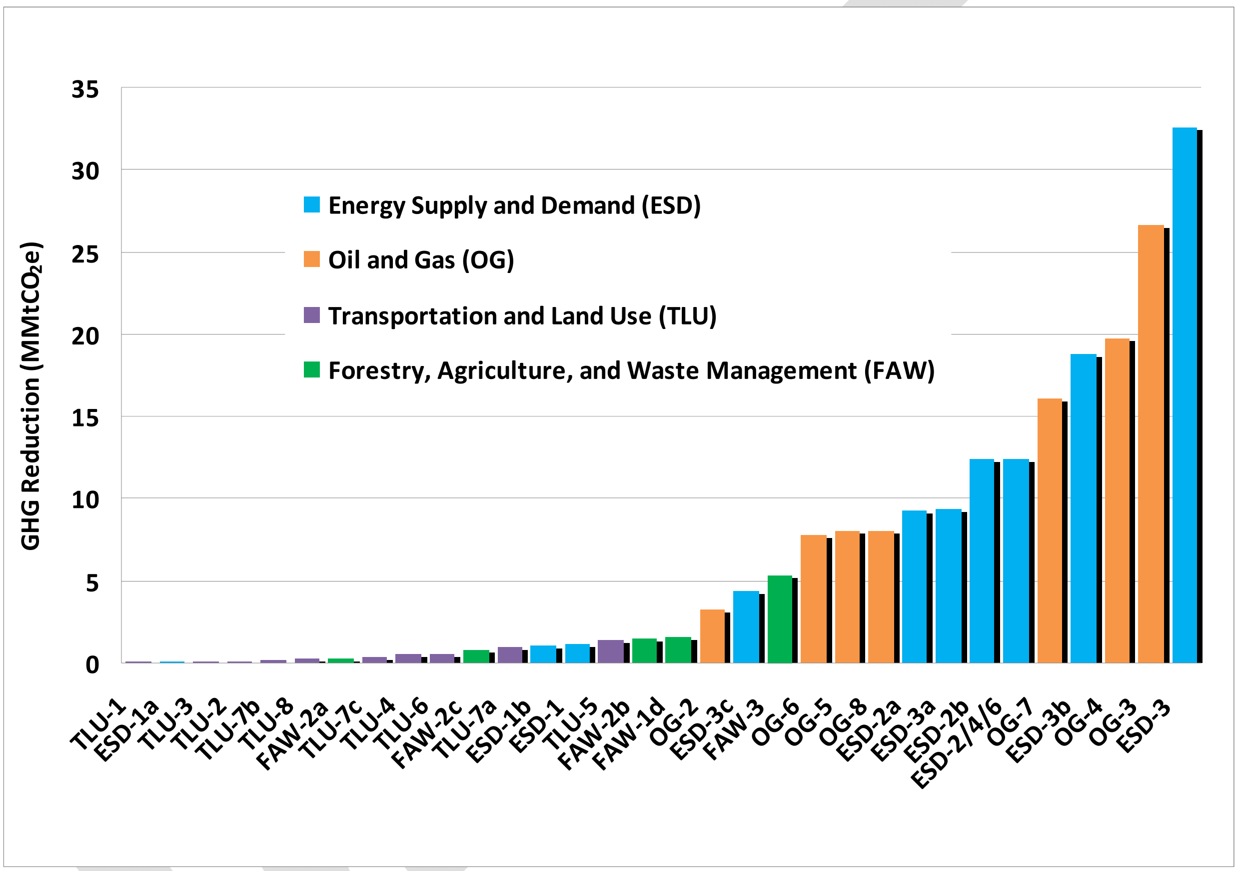
Not shown on the graphs but of interest to the MAG is the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report goal of stabilizing the global atmosphere at 450 parts per million (ppm) of CO_2 (this does not include the five other GHGs, the total of which, when combined with CO_2, is already well above 450ppm). The Cross-Cutting TWG considered the IPCC goal of 450 ppm CO_2 when recommending their goals. The IPCC recognizes that this requires developed nations to achieve reductions of 25-40% below 1990 CO_2 emissions by 2020 and 80-95% reductions below 1990 levels by 2050. Another IPCC scenario is to consider a goal of 550 ppm CO_2e, which means GHG emission reductions of 10-30% below 1990 levels by 2020 and 40-90% below 1990 levels by 2050 for developed nations.[14]

By a small majority, the MAG recommends the Sub-Cabinet consider establishing an aspirational (not legislated) numeric state goal using the above information for guidance. Some of those who objected would prefer not to have a numeric goal.

[14] Pachauri, Dr. R.K., Chairman, IPCC. "New Knowledge on Climate Change: Global Efforts for Meeting the Challenge." Presentation at GCEP Research Symposium, Stanford University, Oct. 2007. http://gcep.stanford.edu/pdfs/kUXNHroC3cAssx6wJoz_Mg/Pachauri-20071001-GCEP.pdf

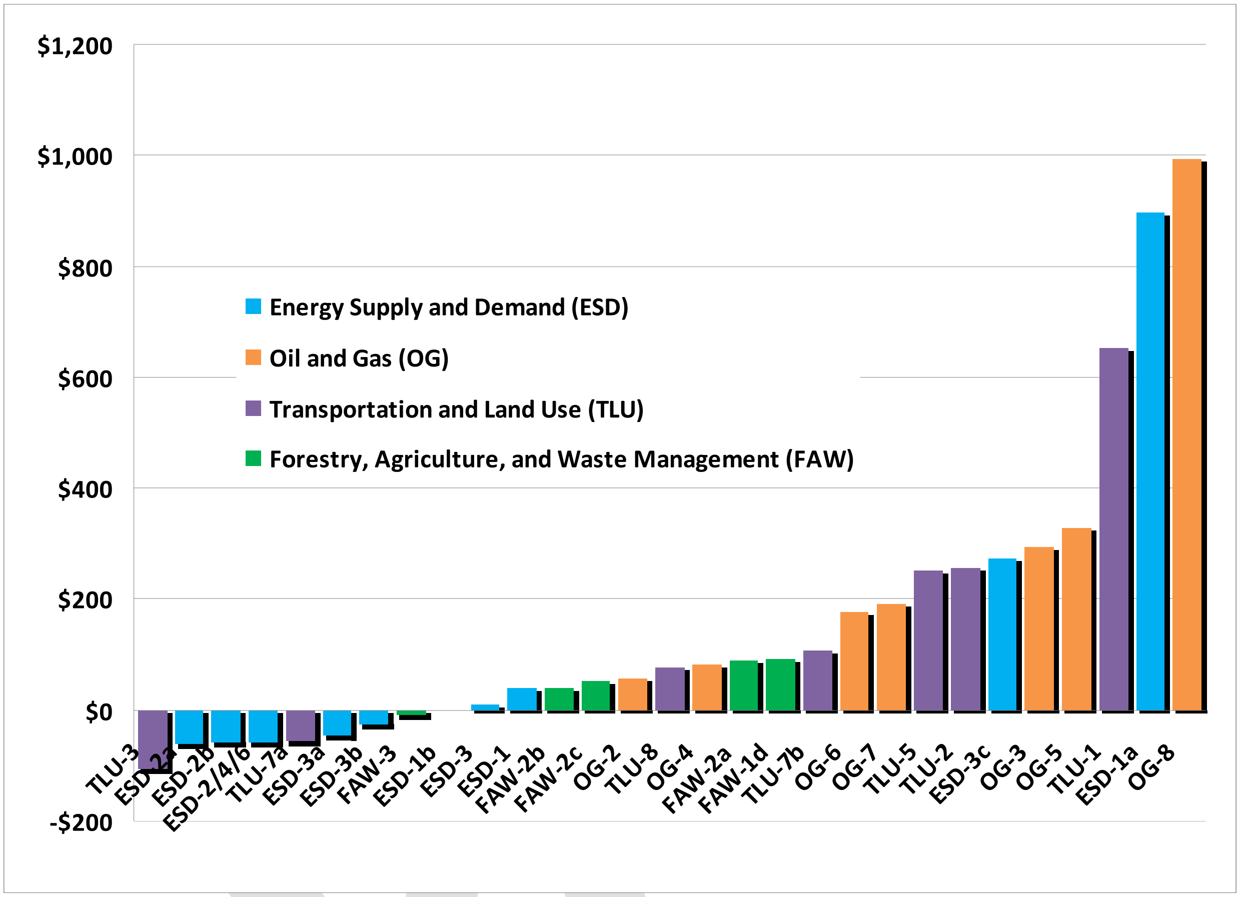
Figure EX-6 displays the cumulative GHG emission reductions projected over the life of each recommended policy option from 2010-2025. Each policy option is identified by the sector it represents and its specific number, which can be cross-referenced in the report's chapters and appendices. Figure EX-7 displays the quantified policy options by their costs or savings per $MMtCO_2e$ reduced. Potential carbon costs associated with a federal cap and trade policy was not included. Note that bars below the base line indicate cost savings.

Figure EX-6. Cumulative GHG reduction potential for each individual Alaska policy recommendation over the period 2010-2025



GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Figure EX-7. Alaska policy recommendations ranked by cost/savings per ton of GHG reduced, 2010–2025



Negative values indicate a cost-savings.

Table EX-3 shows the cumulative emission reductions expected from implementing quantifiable policy recommendations. Any potential double counting from overlaps in policy design and implemenation measures has been eliminated. The costs presented are directly related to the implementation of specific measures, and do not consider ancillary benefits/costs or indirect expenditures or savings. Potential carbon costs associated with a federal cap and trade policy was not included. Negative costs indicate savings.

Table EX-3. Alaska cumulative emissions reductions and costs or savings by sector over the period 2010-2025.

Alaska Cumulative Reductions and Costs/Savings	2015 $MMtCO_2e$	2020 $MMtCO_2e$	2025 $MMtCO_2e$	2010-2025 $MMtCO_2e$	NPV 2010–2025 Cost/ Cost Savings (Million $)	Cost/Savings per Ton CO_2e
Energy Supply and Demand	1.9	3.0	5.3	40.7	–$191	–$5
Oil and Gas	0.75	4.8	4.8	46.2	$7,530	$163
Transportation and Land Use	0.19	0.31	0.42	3.85	$364	$95
Forestry, Agriculture, and Waste Management	0.47	0.8	1.11	9.5	$84	$9
Cross-Cutting						
Total	**3.3**	**9.0**	**11.7**	**100.2**	**$7,787**	**$78.0**

CO_2e = carbon dioxide equivalent; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; NPV = net present value. Negative values reflect savings.

Technical Work Group Recommendations Approved by the Mitigation Advisory Group

Cross-Cutting Issues Policy Recommendations

This TWG reviewed and considered policies related to government lead-by-example actions, outreach, education, GHG inventories and reporting, GHG goals and targets, and financial policies related to climate change.

The CC TWG considered policy options of relevance or benefit across several or all of the sector-specific TWGs. In addition to evaluating emission mitigation activities that cut across sectors, the CC TWG examined policies that enable or provide overall support for other climate actions. The specific GHG reductions and costs of these cross-cutting policies are generally difficult to quantify. Nonetheless, if successfully implemented, the recommended actions presented in Table 4 will support the implementation of other policy recommendations described in the chapters and appendices of this report, and will contribute to GHG emission reductions overall.

Setting a statewide goal occupied much thought and debate throughout the MAG process. A thorough discussion of options, rationale, and findings is found in Chapter 3 and Appendix F, under policy recommendation CC-2. The MAG recognized that the recommendation (CC-1) to establish an Alaska emissions reporting system may be needed, but recommended no action until the status of related federal legislation is known.

Table EX-4 provides an overview of the specific CC recommendations.

Table EX-4. Summary list of Mitigation Advisory Group policy recommendations for Cross-Cutting Issues sector

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)				Net Present Value 2010–2025 (Million 2005$)	Cost-Effective-ness ($\$/tCO_2e$)	Level of Support
		2015	2020	2025	Total 2015–2025			
CC-1	Establish an Alaska Greenhouse Gas Emission Reporting Program	*Not Quantified*						Unanimous (to put on hold)
CC-2	Establish Goals for Statewide GHG Emission Reduction	*Not Quantified*						Majority
CC-3	Identify and Implement State Government Mitigation Actions	*Not Quantified*						Unanimous
CC-4	Integrate Alaska's Climate Change Mitigation Strategy With the Alaska Energy Plan	*Not Quantified*						Unanimous
CC-5	Explore Various Market-Based Systems to Manage GHG Emissions	*Not Quantified*						Unanimous
CC-6	Coordinate Implementation of Alaska's Efforts to Address Climate Change	*Not Quantified*						Super-majority

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization of these important policy recommendations.

Energy Supply and Demand Policy Recommendations

This TWG reviewed and analyzed issues related to energy production and consumption in the residential, commercial, and industrial sectors.

The Energy Supply and Demand (ESD) TWG explored various aspects of ESD issues affecting the daily lives of Alaskans. Overall optimization and expansion of transmission grids, including the feasibility of rural village-to-village lines and renewable energy grants for upgrades, was one area of concern. Energy efficiency across the broad spectrum of residential and commercial customers, along with energy efficiency for industrial installations provided another set of recommendations. Building standard improvements compatible with cold-climate construction and energy efficiency are also recommended.

After careful review, the MAG determined that several other options required more research before policies could be crafted for implementation. Those include efficiency improvements for generators, construction of small nuclear power plants, research and development for cold-climate renewable technologies, and implementation of advanced supply-side technologies. These were forwarded to the Research Needs Work Group for further study.

Table EX-5 presents the ESD policy recommendations, along with their expected GHG emission reductions and the costs of or cost savings from their implementation.

Table EX-5. Summary list of Mitigation Advisory Group policy recommendations for Energy Supply and Demand sector

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)				Net Present Value 2010–2025 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Level of Support
		2015	2020	2025	Total 2010–2025			
ESD-1a	Rural Village-to-Village Transmission	*0.00*	*0.00*	*0.01*	*0.05*	*$44*	*$897*	Unanimous
ESD-1b	Renewable Energy Grants for Transmission Upgrades	*0.06*	*0.08*	*0.09*	*1.06*	*–$2*	*–$2*	Unanimous
ESD-1	Transmission Optimization and Expansion (Total of ESD-1a & ESD-1b)	0.07	0.08	0.09	1.11	$42	$38	Unanimous
ESD-2	Energy Efficiency for Residential and Commercial Customers	*Quantified with ESD-2/4/6*						*See below*
ESD-2/4/6	Energy Efficiency for Residential, Commercial, and Industrial Customers, 2% per year	0.34	1.07	1.84	12.41	–$728	–$59	Unanimous
ESD-3	Implementation of Renewable Energy	1.99	2.35	3.86	32.52	$297	$9	Unanimous
ESD-4	Building Standards/Incentives	*Quantified with ESD-2/4/6*						*See above*
ESD-5	Efficiency Improvements for Generators	*Moved to Research Needs Work Group*						
ESD-6	Energy Efficiency for Industrial Installations	*Quantified with ESD-2/4/6*						*See above*
ESD-7	Implementation of Small-Scale Nuclear Power	*Moved to Research Needs Work Group*						
ESD-8	Research and Development for Cold-Climate Renewable Technologies	*Moved to Research Needs Work Group*						
ESD-9	Implementation of Advanced Supply-Side Technologies	*Moved to Research Needs Work Group*						
	Sector Total After Adjusting for Overlaps*	**1.93**	**2.77**	**4.67**	**37.51**	**–$19.46**	**–$4.24**	
	Reductions From Recent Actions				**0.34**			
	Sector Totals	**1.93**	**2.77**	**4.67**	**37.85**	**–$19.46**	**–$4.24**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent. Note: Sector Total is indicative of potential savings, see note in chapter.

Negative numbers indicate cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

Forestry, Agriculture, and Waste Management Policy Recommendations

This TWG considered and analyzed policy options related to forest management, land conservation, biomass, soil carbon sequestration and sinks, agriculture, and waste management.

The Forest, Agriculture, and Waste Management (FAW) TWG identified three broad policies for MAG approval. The first, forest management, focused on management strategies for coastal and boreal forests, wildfire risk reduction, and forest restoration. The second area of recommendations dealt with biomass-to-energy issues, using biomass to offset fossil fuel-based heating, power, and fuel needs. The final area of study was municipal solid waste, specifically strategies for reducing waste and recycling.

All four FAW-1 options have the potential to produce biomass that can be used for fuel feedstocks under FAW-2. The GHG reductions for using the biomass from FAW-1 or other sources were quantified under FAW-2. The MAG recognizes that the costs to collect, process, and transport most of the biomass generated from coastal forest thinning projects will be too costly to use as an energy source.

One other policy, not listed Table EX-6, is fostering the growth and management of healthy forests in Alaska, and getting the most possible benefits from Alaska's forestland. While the GHG benefits of adaptation policies are not quantified, this policy nonetheless can provide additional insight into issues of forest health.

There are no overlaps between the FAW biomass policies and the policies in the ESD or Transportation and Land Use (TLU) appendices. Biomass demand from ESD-3 has been accounted for in the biomass availability analysis found in Appendix H. FAW Policy Recommendations.

Table EX-6 displays specific results for each recommended policy and subcategories within those policies.

Table EX-6. Summary list of Mitigation Advisory Group Policy recommendations for Forestry, Agriculture, and Waste Management sector

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)				Net Present Value 2010–2025 (Million 2005$)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2015	2020	2025	Total 2010–2025			
FAW-1	Forest Management Strategies for Carbon Sequestration							
	A. Coastal Forest Management Pre-Commercial Thinning	Included under FAW-2, along with all options using biomass in other sectors						Unanimous
	B. Boreal Forest Mechanical Fuels Treatment Projects							Unanimous
	C. Community Wildfire Risk Reduction Plans							Unanimous
	D. Boreal Forest Reforestation After Fire or Insect and Disease Mortality	0.09	0.12	0.15	1.6	$150	$92	Unanimous
FAW-2	Expanded Use of Biomass Feedstocks for Energy Production							
	A. Biomass Feedstocks to Offset Heating Oil Use	0.01	0.03	0.04	0.3	$27	$90	Unanimous
	B. Biomass Feedstocks for Electricity Use	0.07	0.12	0.18	1.5	$59	$38	Unanimous
	C. Biomass Feedstocks to Offset Fossil Transportation Fuels	0.03	0.06	0.09	0.8	$41	$52	Unanimous
FAW-3	Advanced Waste Reduction and Recycling	0.27	0.45	0.65	5.3	–$43	–$8	Unanimous
	Sector Total Before Adjusting for Overlaps	0.47	0.78	1.11	9.5	$234	$25	
	Sector Total After Adjusting for Overlaps	0.47	0.78	1.11	9.5	$234	$25	
	Reductions From Recent Actions (CAFE standards)	N/A	N/A	N/A	N/A	N/A	N/A	
	Sector Total + Recent Actions	0.47	0.78	1.11	9.5	$234	$25	

CAFÉ = Corporate Average Fuel Economy; FAW = Forestry, Agriculture, and Waste Management (Technical Work Group); GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Negative numbers indicate cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

Oil and Gas Policy Recommendations

This TWG considered and analyzed policy options related to the full spectrum of oil and gas production, processing, transmission and associated fuel use for all related GHG emissions.

The Oil and Gas TWG carefully analyzed a wide variety of options to reduce GHG emissions from oil and gas operations in Alaska. To do so required assessing actual outputs and production projections from discrete facilities; these are identified geographically. Some facilities lend themselves to effective implementation of certain recommendations, whereas those same recommendations may not be effective elsewhere due to size, scope, or projected longevity of production. Facility-specific recommendations are clearly identified in Appendix I: Oil and Gas Policy Recommendations.

The TWG examined conservation; reduction of fugitive methane emissions; centralized electrification of North Slope operations; upgrades and efficiency of fossil fuel consuming equipment; renewable energy substitutes for fossil fuel energy; and carbon capture. Various ways of dealing with carbon post-capture were examined. Use of the carbon depended on location and source of the GHG (see Policy Recommendations OG-6, 7 and 8).

In quantifying the options, it became clear that besides conservation, most would be very expensive to implement and had other attendant issues that need to be resolved prior to implementation. What these recommendations represent is a suite of the best opportunities to reduce GHG emissions from oil and gas sector operations, but that does not mean they are cheap, easy or ready to implement. Rather, the investigations within this report recommend the areas for further study. Note that a federal cap and trade policy or other added costs for carbon emissions may change the economics.

Table EX-7 describes the Oil and Gas sector policies, their projected GHG emission reductions and the direct costs. There is overlap amongst the options, that is, options that accounting for the same GHG emissions. Depending on which policies are implemented, the overlap would vary. For that reason, the overlap figures are presented as a range.

Table EX-7. Summary list of Mitigation Advisory Group policy recommendations for the Oil and Gas sector

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)				Net Present Value 2010–2025 (Million 2009$)	Cost-Effective-ness (2009$ /tCO_2e)	Level of Support
		2015	2020	2025	Total 2010–2025			
OG-1	Best Conservation Practices	*Not Quantified*						Unanimous
OG-2	Reductions in Fugitive Methane Emissions	0.2	0.2	0.2	3.2	$181.4	$57	Unanimous
OG-3	Electrification of North Slope Oil and Gas Operations, With Centralized Power Production and Distribution	—	3.0	4.4	26.6	$7,791.0	$293	Unanimous
OG-4	Improved Efficiency Upgrades for Oil and Gas Fuel-Burning Equipment	0.5	2.1	2.1	19.7	$1,600.1	$81	Unanimous
OG-5	Renewable Energy Sources in Oil and Gas Operations	0.7	0.7	0.7	8.0	$2,603.4	$327	Unanimous
OG-6	Carbon Capture (From North Slope High-CO_2 Fuel Gas) and Geologic Sequestration With Enhanced Oil Recovery	—	0.9	0.9	7.8	$1,368.8	$176	Unanimous
OG-7	Carbon Capture (From Exhaust Gas at a Centralized Facility) and Geologic Sequestration With Enhanced Oil Recovery	—	1.8	1.8	16.1	$3,094.1	$192	Unanimous
OG-8	Carbon Capture (From Exhaust Gas) and Geologic Sequestration Away From Known Geologic Traps	0.7	0.7	0.7	8.0	$7,937.7	$994	Unanimously not recommended at this time
	Sector Total Before Adjusting for Overlaps	**2.1**	**9.4**	**10.8**	**89.4**	**$24,576.5**		
	Sector Total After Adjusting for Different Implementation Strategies*	**0.2/ 0.8**	**6.7/ 4.8**	**10.0-4.8**	**62.9/ 46.2**	**$15,300/ $7,500**	**$243/$163**	
	Reductions From Recent Actions (CAFE Standards)	**0**	**0**	**0**	**0**	**0**		

NOTES:

Policy options were modeled on generic, publicly available industry data from North Slope oil and gas operations. Thus, the results must only be used to help direct more precise modeling, which would include, for example, taxes, royalties, individual oil and gas facility data, and specific engineering studies.

'"Net Present Value" used in the summary table above would be regarded in the oil and gas industry as "Net Present Cost." Positive numbers in the two right-hand columns indicate that an investment in the policy would generate a financial loss.

"Net Present Value" and "Cost-Effectiveness" values do not apply in Cook Inlet or any other oil and gas basin, due to vastly different production life, geographic distribution, and physical constraints.

Due to the analytical methodology, "Cost Effectiveness" is likely lower than the break-even cost of carbon needed to make a project economically feasible.

None of the modeling included the impact of short-term production loss to implement the policies OG-2 though OG-7.

These policies are technology-based opportunities for reducing greenhouse gas emissions (GHG), not policies to be directly implemented by Alaska.

The GHG savings estimates presented here are not additive. Policies have significant, sometimes complete, overlap in targeted GHG emissions.

CAFE = corporate average fuel economy; CO_2 = carbon dioxide; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; OG = oil and gas.

*This range shows emissions reductions and costs if only the more cost-effective options were implemented, i.e., dropping sequestration away from geologic sources (OG-8) and keeping the rest (the first set of figures). The second set represents removal of the central electrification (OG-3) and sequestration away from geologic sources (OG-8).

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

Transportation and Land Use Policy Recommendations

This TWG considered and analyzed policy options related to transportation methods, modalities, efficiencies, infrastructure, planning, land use and development as they relate to and/or generate GHG emissions.

The TLU TWG focused on and analyzed vehicle and transportation policy recommendations, specifically pertaining to public transit and commuter options; heavy-duty vehicle idling, fleet management and other efficiencies; land transportation systems; marine vessel efficiencies; and aviation emission reductions. Land use policies recommended include efficient development patterns (smart growth) and using vehicle-miles-traveled and GHG emission reduction as planning metrics.

Table EX-8 displays the policy recommendations, and where they could be quantified, the amount of expected GHG emission reductions and the direct costs for such action.

Table EX-8. Summary list of Mitigation Advisory Group policy recommendations for the Transportation and Land Use sector

Policy No.	Policy Recommendation	GHG Reductions (MMtCO$_2$e) 2015	2020	2025	Total 2010–2025	Net Present Value 2010–2025 (Million 2005$)	Cost-Effective-ness ($/tCO$_2$e)	Level of Support
TLU-1	Transit, Ridesharing, and Commuter Choice Programs	0.002	0.003	0.005	0.046	$29.9	$651	Unanimous
TLU-2	Heavy-Duty Vehicle Idling Regulations and/or Alternatives	0.004	0.009	0.009	0.095	$24.3	$255	Unanimous
TLU-3	Transportation System Management	0.006	0.006	0.006	0.092	–$9.7	–$105	Unanimous
TLU-4	Promote Efficient Development Patterns (Smart Growth)	0.019	0.043	0.066	0.501	Net Savings	NQ	Unanimous
TLU-5	Promotion of Alternative-Fuel Vehicles	0.026–0.084	0.054–0.173	0.09–0.288	0.669–2.139	$207.3–$494.8	$135–$740	Unanimous
TLU-6	VMT and GHG Reduction Goals in Planning	0.019	0.043	0.066	0.501	NQ	NQ	Unanimous
TLU-7	On-Road Heavy-Duty Vehicle Efficiency Improvements: a. SmartWay®	0.050	0.075	0.084	0.930	–$52.3	–$56	Unanimous
	b. Phase Out	0.025	0.012	0.000	0.198	$20.9	$106	
	c. Public Fleets	0.016	0.033	0.037	0.364	NQ	NQ	
TLU-8	Marine Vessel Efficiency Improvements	0.012	0.022	0.032	0.269	$20.4	$76	Unanimous
TLU-9	Aviation Emission Reductions	NQ	NQ	NQ	NQ	NQ	NQ	Unanimous
TLU-10	Alternative Fuels Research and Development	NQ	NQ	NQ	NQ	NQ	NQ	Unanimous
	Sector Total Before Adjusting for Overlaps	**0.210**	**0.363**	**0.500**	**4.444**	**$364.3**	**$82**	
	Sector Total After Adjusting for Overlaps	**0.187**	**0.313**	**0.423**	**3.850**	**$364.3***	**$95***	
	Reductions From Recent Actions	**0.397**	**0.531**	**0.732**	**5.995**	**NQ**	**NQ**	
	Sector Total Plus Recent Actions	**0.412**	**0.844**	**1.155**	**9.845**	**NQ**	**NQ**	

*Does not include any cost for policies TLU-4, TLU-6, or TLU-7c, but does include emission reductions for those policies.

GHG = greenhouse gas; MMtCO$_2$e = million metric tons of carbon dioxide equivalent; $/tCO$_2$e = dollars per metric ton of carbon dioxide equivalent; NQ = not quantified; VMT = vehicle miles traveled.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

Negative numbers indicate cost savings.