Appendix E
Quantification Methods and Assumptions

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Quantification Memorandum

Date: October 31, 2008

To: Alaska Climate Change Mitigation Advisory Group (MAG)

From: The Center for Climate Strategies

Subject: Quantification of Climate Mitigation Policy Options

This memo summarizes key elements of the recommended methodology for estimating reductions in GHG emissions and the cost effectiveness in achieving these reductions for those draft policy options amenable to such quantification. The quantification process is intended to support custom design and analysis of draft policy options, and provide both consistency and flexibility. Feedback is encouraged.

Key guidelines include:

- Focus of analysis: **Net GHG reduction potential** in physical units of million metric tons (MMt) of carbon dioxide equivalent (CO_2e) and **net cost per metric ton reduced** in units of dollars per metric ton of carbon dioxide equivalent ($/t$CO_2e$). Where possible, full life cycle analysis is used to evaluate the net energy (and emissions) performance of actions (taking into account all energy inputs and outputs to production). Net analysis of the effects of carbon sequestration is conducted where applicable.
- Cost-effectiveness: Because monetized dollar values of GHG reduction benefits are not available, physical benefits are used instead, measured as dollars per metric ton of carbon dioxide equivalent ($/t$CO_2e$) (i.e., cost or savings per ton) or "cost effectiveness" evaluation. Both positive costs and cost savings ("negative costs") are estimated in the course of the cost effectiveness analysis.
- Geographic inclusion: Measure GHG impacts of activities that occur within the state, regardless of the actual location of emissions reductions. For instance, a major benefit of recycling is the reduction in material extraction and processing (e.g., aluminum production). While a policy option may increase recycling in Alaska, the reduction in emissions may occur where this material is produced. Where significant emissions impacts are likely to

occur outside the state, this will be clearly indicated. These emissions reductions are counted towards the achievement of the state's emission goal, since they result from actions taken by or within the state.

- Direct vs. indirect effects: "Direct effects" are those borne by the entities implementing the policy recommendation. Direct costs are net of any financial benefits or savings to the entity. "Indirect effects" are defined as those borne by entities other than those implementing the policy recommendation. Indirect effects will be quantified on a case-by-case basis depending on magnitude, importance, time and resources available, need, and availability of data. (See additional discussion and examples below.)

- Non-GHG impacts and costs: The recommended quantification process allows for an "apples to apples" comparison among different policy options for reducing GHG emissions. This is important in identifying meaningful and efficient options. However, it is beyond the scope of this quantification to assess broader economic impacts, which could be material, or distributional effects that implementing certain policy options could have on particular businesses, business sectors or regions of Alaska. The quantification of GHG impacts can be supplemented by describing in qualitative terms potential material non-GHG impacts, and where deemed important, these potential non-GHG impacts can be quantified on a case-by-case basis provided the necessary time, resources, and data are available. Follow-on efforts to evaluate broader economic and/or non-GHG impacts could be done before the MAG makes its final recommendations on policy options to the Climate Change Sub-Cabinet, or by the Sub-Cabinet before it determines its final recommendations. Further, the MAG could include in its policy recommendations a description of additional, supplemental assessment of non-GHG impacts it believes necessary before a final decision is reached concerning implementation of particular mitigation policies.

- Discounting and annualizing: Discount a multi-year stream of net costs (or savings) to arrive at the "net present value" of the cost of implementing a policy option. Discount costs to constant 2007 dollars using a 5% annual real discount rate for the project period of 2009 through 2020 (unless otherwise specified for the particular policy option). Capital investments are represented in terms of annualized or amortized costs through 2020. Create a levelized cost per ton by dividing the present value cost or cost savings by the cumulative reduction in tons of GHG emissions.

- Time period of analysis: Count the impacts of actions that occur during the project time period and, using annualized emissions reduction and cost analysis, report emissions reductions and costs for specific target years of 2015 and 2020. Where additional GHG reductions or costs occur beyond the project period as a direct result of actions taken during the project period, show these to the extent practicable for comparison and potential inclusion.

- Aggregation of cumulative impacts of policy options: In addition to "stand alone" results for individual policy options, estimate the cumulative impacts of all policy options combined. This aggregation avoids double-counting of GHG reductions and costs that would occur were emission reductions and costs associated with all of the policy recommendations simply added together. In doing so, interactive effects between policy recommendations are noted and estimated as appropriate using analytical methods where significant overlap or equilibrium effects are likely.

- Policy design specifications and other key assumptions: Explicit goal levels, timing, implementing parties, type of implementation mechanism, and other key assumptions are as determined by the Alaska Mitigation Advisory Group (MAG) and included in the individual policy option descriptions.
- Transparency: Specific policy design choices (as noted above) as well as data sources, methods, key assumptions, and key uncertainties are as approved by the MAG and recorded transparently in the policy options document. Data and comments provided by the MAG reflecting its members' expertise and knowledge ensure the use of best available data sources, methods, and key assumptions to address specific issues in Alaska. Any modifications are made through facilitated decisions by the MAG.

For additional reference, see the economic analysis guidelines developed by the Science Advisory Board of the US EPA available at: http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html.

Examples of Direct/Indirect Net Costs and Savings

Note: These examples are meant to be illustrative, not exhaustive nor determinative.

Residential, Commercial, and Industrial (RCI) Energy Demand Sectors

Direct Costs and/or Savings

- Net capital costs (or incremental costs relative to standard practice) of improved buildings, appliances, equipment (e.g., cost of higher-efficiency refrigerator versus refrigerator of similar features that meets standards)
- Net operation and maintenance (O&M) costs (relative to standard practice) of improved buildings, appliances, equipment, including avoided/extra labor costs for maintenance (e.g., less changing of compact fluorescent lights (CFL) or light-emitting diodes (LED) in lamps relative to incandescent bulbs)
- Net fuel (gas, electricity, biomass, etc.) costs (typically as avoided costs from a societal perspective)
- Cost/value of net water use/savings
- Cost/value of net materials use/savings (e.g., raw materials savings via recycling, or lower/higher cost of low-global warming potential (GWP) refrigerants)
- Direct improved productivity as a result of industrial measures, measured as change in cost per unit output (e.g., for an energy/GHG-saving improvement that also speeds up a production line or results in higher product yield)

Indirect Costs and/or Savings

- Re-spending effect on economy
- Net value of employment impacts
- Net value of health benefits/impacts
- Value of net environmental benefits/impacts (e.g., value of damage by air pollutants on structures, crops, etc.)

- Net embodied energy of materials used in buildings, appliances, equipment, relative to standard practice
- Improved productivity as a result of an improved working environment, such as improved office productivity through improved lighting (though the inclusion of this as indirect might be argued in some cases)

Energy Supply (ES) Sector

Direct Costs and/or Savings

- Net capital costs (or incremental costs relative to reference case technologies) of renewables or other advanced technologies resulting from policies
- Net O&M costs (relative to reference case technologies) of renewables or other advanced technologies resulting from policies
- Avoided or net fuel savings (gas, coal, biomass, etc.) of renewables or other advanced technologies relative to reference case technologies resulting from policies
- Total system costs (net capital + net O&M + avoided/net fuel savings + net imports/exports + net transmission and distribution (T&D) costs) relative to reference case total system costs

Indirect Costs and/or Savings

- Re-spending effect on economy
- Higher cost of electricity reverberating through economy
- Value of improved energy security
- Net value of employment impacts
- Net value of health benefits/impacts
- Value of net environmental benefits/impacts (e.g., value of damage by air pollutants on structures, crops, etc.)

Agriculture, Forestry, and Waste Management (AFW) Sectors

Direct Costs and/or Savings

- Net capital costs (or incremental costs relative to standard practice) of facilities or equipment (e.g., manure digesters and associated infrastructure, generator; ethanol production facility)
- Net O&M costs (relative to standard practice) of equipment or facilities
- Net fuel (gas, electricity, biomass, etc.) costs or avoided costs
- Cost/value of net water use/savings

Indirect Costs and/or Savings

- Net value of employment impacts

- Net value of human health benefits/impacts
- Net value of ecosystem health benefits/impacts (e.g., wildlife habitat; reduction in wildfire potential; etc.)
- Value of net environmental benefits/impacts (e.g., value of damage by air or water pollutants on structures, crops, etc.)
- Net embodied energy of water use in equipment or facilities relative to standard practice
- Reduced VMT and fuel consumption associated with land use conversions (e.g., as a result of forest/rangeland/cropland protection policies)

Transportation and Land Use (TLU) Sector

Direct Costs and/or Savings

- Incremental cost of more efficient vehicles net of fuel savings
- Incremental cost of implementing "Smart Growth" programs, net of saved infrastructure costs
- Incremental cost of mass transit investment and operating expenses, net of saved infrastructure costs (e.g., roads)
- Incremental cost of alternative fuel, net of any change in maintenance costs

Indirect Costs and/or Savings

- Health benefits of reduced air and water pollution.
- Ecosystem benefits of reduced air and water pollution.
- Value of quality-of-life improvements.
- Value of improved road safety.
- Value of improved energy security
- Net value of employment impacts

Cross Cutting Issues (CC) Sectors

No Cross Cutting policy options were quantified.

Oil and Gas (OG) Sector

The nature of the issues addressed in the Oil and Gas sector led to use of additional quantification approaches beyond those noted here. They are detailed in the discussion found in *Chapter 6 Oil and Gas* and *Appendix I Oil and Gas Policy Recommendations*.