

Potential Scenarios for Investigation of Externality Costs from Electric Generation Unit Emissions

Background

In 1993, the Legislature enacted Minn. Stat. §216B.2422, subd. 3, to require the Minnesota Public Utilities Commission (Commission) to “quantify and establish a range of environmental costs associated with each method of electricity generation.” These environmental costs, or “externality values,” include the costs of the damages from emissions produced by power plants that are borne by society as a whole, rather than being borne directly by electric utilities or the consumers of electricity. The statute requires utilities to use the values in Commission proceedings “in conjunction with other external factors, including socioeconomic costs, when evaluating and selecting resource options”

The Commission established interim cost values in 1994, and final values in 1997, for Sulfur Dioxide (SO₂), Carbon Monoxide (CO), Carbon Dioxide (CO₂), Nitrogen Oxides (NO_x), Lead (Pb), and particulate matter less than 10 microns in diameter (PM₁₀). These values are updated annually for inflation.

In December 2013, a motion to reopen the investigation on externality values for particulate matter less than 2.5 microns in diameter (PM_{2.5}), SO₂, NO_x, and CO₂ came before the Commission. In its February 10, 2014 Order, the Commission granted the motion, and requested that the Department of Commerce and the Pollution Control Agency (together, the Agencies) convene a stakeholder group to address the scope of the investigation, whether to retain an expert under Minn. Stat. §216B.62, subd. 8, and the possible role of an expert should one be retained.

In response to the Commission’s Order, this April 24, 2014 meeting is being facilitated by staff from Minnesota Management and Budget’s Management Analysis & Development (MAD) to gather input from interested stakeholders. Stakeholders’ oral comments will be compiled and summarized by MAD staff in the form of a report. After considering stakeholder input, the Agencies will provide a recommendation to the Commission regarding the scope of the investigation by June 10, 2014. The Agencies’ recommendation will include, as an attachment, MAD’s report of this stakeholder meeting.

Written comments are welcome and must be provided by May 9, 2014 to ensure consideration by the Agencies. Provide written comments by filing them electronically using the Commission’s edocket system. Go to <https://www.edockets.state.mn.us/EFiling/security/login.do?method=showLogin> and follow the prompts. The docket number to use is **00-1636**. Alternatively, you can submit written comments to externalities.comments@state.mn.us. The Department of Commerce will compile all comments submitted to externalities.comments@state.mn.us and file them in eDockets under “Public Comment.”

Scope and Process Questions for Stakeholder Input

1. Provide comment on the below proposed criteria for evaluation of the scenarios. Are there other criteria that should be considered?
2. Describe which of the potential process scenarios outlined below you support for development of externality values for criteria pollutants. For CO₂?
3. What input do you have on the general scope of this investigation?
4. Should additional greenhouse gasses besides CO₂ be included in the investigation?
5. What other information exists that is critical to informing how the pollutant externality costs are updated?

Expert Role Questions for Stakeholder Input

6. Should an outside contractor (“expert”) be retained to do this work?
7. If an expert is retained what should be their role?
8. If an expert is retained, what are the critical competencies needed for your preferred criteria pollutant scenario? For your preferred CO₂ scenario?

Proposed Criteria Used to Evaluate Process Scenarios

1. **Cost:** total cost to complete the analysis, evaluated relative to other options
2. **Time to completion:** estimated time from PUC decision of scenario to pursue to completion of analysis
3. **Complexity:** relative complexity of the analytical methods involved in the scenario
4. **Credibility:** relative degree to which analytical models represent the complexity of the systems being modeled and thus the relative confidence in the accuracy of the estimates they produce
5. **Specificity to Minnesota:** degree to which specific conditions of Minnesota are incorporated into the modeling
6. **Need for outside contractor:** likely need for an outside contractor to conduct the analysis
7. **Update ability:** relative ease to which externality value estimates could be updated in the future

Potential Process Scenarios (See the appended *Technical Details* document for additional detail)

Note: The process scenarios outlined below are based on preliminary evaluation by agency staff for the purpose of inviting comment.

Criteria Pollutants Externality Values

TASK: Develop an externality cost value (\$/ton of pollutant emitted) for these pollutants: **SO₂**, **NO_x**, **PM_{2.5}**

Scenario A: Full photochemical modelling of air quality resulting from emissions from Minnesota electric generating units (EGUs) followed by analysis of health and environmental impacts using epidemiological studies and estimation of values using economic valuation studies.

Cost	Completion Time	Complexity	Credibility	Specificity to MN	Need for Outside Contractor?	Update Ability
High	Likely greater than one year	High	High	High	Yes	High effort

Scenario B: Employ reduced form model (e.g. the Air Pollution Emission Experiments and Policy analysis (APEEP) model) that estimates dollars per ton values for Minnesota power plants, but parameterize the model specifically to Minnesota (e.g., just consider damages in MN).

Cost	Completion Time	Complexity	Credibility	Specificity to MN	Need for Outside Contractor?	Update Ability
Low-Medium	Likely less than one year	Medium	Medium	Medium	Possibly	Medium effort

Scenario C: Utilize EPA air quality modelling for state-specific air quality resulting from anthropogenic emissions, already done for regulatory impact assessments followed by analysis of health and environmental impacts using epidemiological studies and estimation of values using economic valuation studies.

Cost	Completion Time	Complexity	Credibility	Specificity to MN	Need for Outside Contractor?	Update Ability
Low	Likely less than one year	Low - Medium	Low - Medium	Medium	No	Depends on future production of updated estimates

CO₂ Externality Values

TASK: Develop an externality cost value (\$/ton of pollutant emitted) for carbon dioxide (CO₂). Note the geographic limitations of the environmental cost value will not be changed from the current PUC value.

Scenario D: Hire outside contractor to determine the process for assigning externality values from MN EGUs for CO₂. The contractor also assesses the need for externality values for other greenhouse gasses and the analytical methods to estimate them.

Cost	Completion Time	Complexity	Credibility	Specificity to MN	Need for Outside Contractor?	Update Ability
Medium	Uncertain	Medium	High	N/A	Yes	Uncertain

Scenario E: Apply federal government interagency group social cost of carbon estimates (central estimate along with alternate values based on different discount rates); include other greenhouse gasses as CO₂-equivalents using the global warming potential index.

Cost	Completion Time	Complexity	Credibility	Specificity to MN	Need for Outside Contractor?	Update Ability
Low	Likely less than one year	Low	High	N/A	No	Low effort

Scenario F: Apply federal government interagency group social cost of carbon estimates (central estimate along with alternate values based on different discount rates); exclude other greenhouse gasses.

Cost	Completion Time	Complexity	Credibility	Specificity to MN	Need for Outside Contractor?	Update Ability
Low	Likely less than one year	Low	High	N/A	No	Low effort

Supplemental Document: Technical Details

Scenario A: Full Photochemical Air Quality Modelling for Criteria Pollutants

Photochemical air quality models are large-scale models that simulate the changes of pollutant concentrations in the atmosphere using a set of mathematical equations characterizing the chemical and physical processes in the atmosphere. EPA's Community Multi-scale Air Quality Model (CMAQ) is a photochemical model likely to be used for this analysis. Other potential photochemical models are the Comprehensive Air Quality Model with Extensions (CAMx), and the Weather Research and Forecasting model coupled with Chemistry (WRF-CHEM). CMAQ uses emissions, meteorology, and chemical modelling to predict air quality concentrations of ozone, particulates, and toxics.

The specific methodology to employ photochemical modeling for this purpose will be determined by the analysts, but a rough sketch of a potential methodology would be to do the following for each pollutant (SO₂, NO_x, PM_{2.5}) under consideration:

- 1) Zero out all emissions of the pollutant from all electric generation units (EGUs) in Minnesota urban counties
- 2) Run the model to determine air quality (PM_{2.5} and ozone) across the state of Minnesota to get a "control" air quality surface that can then be compared to the "baseline" air quality surface had emissions of the pollutant not been zeroed out.
- 3) Repeat the above steps for all EGUs in Minnesota's metropolitan fringe area and in Minnesota's rural area.

The steps listed above present a rough idea of the methodology process. Details, including the timing of the modeling (*e.g.*, the year[s] for which baseline and control air quality surfaces are determined) and the geographic resolution of the modelling, would need to be determined

Once baseline and control air quality scenarios are generated for each criteria pollutant and each geographic region then EPA's Environmental Benefits Mapping and Analysis (BenMAP) model could be used to estimate the differences in health impacts and economic values of those impacts between baseline and control air quality levels across the state. BenMAP uses health impact functions from the peer-reviewed epidemiological literature to estimate health impacts. Furthermore, BenMAP can convert predicted health impacts to economic values using valuation functions from the economic valuation literature. Thus, for each pollutant in each geographic region, BenMAP can estimate total economic damages in Minnesota resulting from EGU emissions of that pollutant. Dividing total economic damages by the total Minnesota EGU emissions of a pollutant in a geographic region can then estimate dollar per ton damage values (only considering damages within in Minnesota) for EGU emissions of that pollutant in the geographic region of the state.

This methodology would not take into account non-human health impacts of these pollutants, such as materials damage, but analysts could develop other tools for estimating the economic values of these impacts.

Scenario B: Reduced Form Model for Criteria Pollutants

A reduced form model represents relationships between the environment and pollutants in a simplified manner designed to mimic the essential relationship elements while remaining fast and inexpensive to run across multiple scenarios.¹ A widely used reduced form model for estimating economic damages from air pollution is the Air Pollution Emission Experiments and Policy Analysis (APEEP) model. APEEP is an integrated assessment model that links emissions of air pollution from all point sources (including EGUs) within the U.S. to exposures, physical effects, and monetary damages. APEEP has been used in many peer-reviewed publications and has withstood some legal scrutiny, having been used to quantify damages in a law suit by the EPA of a Louisiana coal-fired power plant.

Although APEEP generally serves to estimate overall damages from air emissions, the model can be customized to include only damages within Minnesota. Other model parameters, such as the year(s) of estimates, could be customized. APEEP could be used to come up with separate estimates for damages from different geographic regions of Minnesota (urban, metropolitan fringe, rural).

InMAP is another reduced form model being developed here in Minnesota to estimate health impacts of air pollution. This is an as-yet untested model, but may have more specificity to Minnesota conditions and thus may also be considered as a candidate reduced-form model.

Scenario C: Existing State-Specific Air Modelling of Anthropogenic Emissions by EPA for Regulatory Impact Assessment

EPA has done state-by-state estimates of economic damages from anthropogenic emissions as part of the cost benefit analyses in its regulatory impact assessments. In 2011, to support the regulatory impact assessment for the Final Transport Rule, the EPA used CMAQ to quantify the impacts (air quality contributions) of SO₂ and NO_x anthropogenic emissions on PM_{2.5} and ozone concentrations. Although these do not specifically examine emissions from EGUs, they do quantify impacts from the specific pollutants under consideration in this analysis. These air quality impacts could then be used as inputs into BenMAP to estimate health impacts and economic values of the impacts as described above.

Scenario D: Outside Contractor Determines Appropriate Greenhouse Gas (CO₂ and Perhaps Others) Values for Minnesota

There have been numerous studies to estimate global economic damages from carbon (and other greenhouse gas) emitted to the atmosphere. It would be contingent on the analysts to determine the most appropriate estimate, or to develop new estimates, for use in Minnesota.

¹ The Air Pollution Emission Experiments and Policy Analysis Model (APEEP) Technical Appendix. http://www.econ.yale.edu/~nordhaus/Resources/muller_JEEM_Appendix.pdf.

Scenario E: Federal Government Social Cost of Carbon Estimates with Inclusion of Other Greenhouse Gasses as CO₂-equivalents

The U.S. Government Interagency Working Group on Social Cost of Carbon consists of 11 federal agencies the Department of Energy, The Department of Agriculture, the Department of the Treasury and the Environmental Protection Agency. In 2010 this group developed estimates for the social cost of carbon (SCC). The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change. The Working Group convened again in 2013 to update its estimates. The 2013 SCC estimates by this interagency group for emissions in 2015 are a central estimate of \$36 per ton CO₂ (in 2007 dollars, using a 3% discount rate), and a range of \$11 to \$55 per ton CO₂ emitted in 2015 when alternative discount rates (5% and 2.5%, respectively) were used in the analysis. SCC estimates in future years rise steadily, reflecting generally greater expected impacts as atmospheric concentrations of carbon increase. These estimates collapse a great deal of information into single values, namely results from Integrated Assessment Models (IAMs) that model the atmospheric response to carbon emissions, the climate response to atmospheric changes, the human welfare impacts of climate change and the economic values of these impacts at a chosen discount rate.

Other greenhouse gasses (methane, nitrous oxide, hydroflouorocarbons, perflouorocarbons and sulfur hexafluoride) can be converted into CO₂-equivalents using the Global Warming Potential (GWP) Index. GWP is a relative measure of how much heat a greenhouse gas traps in the atmosphere and compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of CO₂. Thus, the GWP values have been used to convert all of the additional gasses under consideration here into CO₂-equivalents (CO₂-e). Once any gas has been converted into its CO₂-e the marginal damage of a ton of that gas, or the externality cost, can be calculated using the SCC. It should be noted that the vast majority of greenhouse gas emissions from EGUs is in the form of CO₂ so that including externality values of other greenhouse gasses will not significantly affect the overall damage estimates of EGU emissions from fossil fuel based power plants.

Scenario F: Federal Government Social Cost of Carbon Estimates and Exclusion of Other Greenhouse Gasses

Same process as described above without the inclusion of other greenhouse gases.

CERTIFICATE OF SERVICE

I, Jan Mottaz, hereby certify that I have this day, served copies of the following document on the attached list of persons by electronic filing, e-mail, or by depositing a true and correct copy thereof properly enveloped with postage paid in the United States Mail at St. Paul, Minnesota.

Response of the Minnesota Department of Commerce, Division of Energy Environmental Review & Analysis

Docket No. E-999/CI-00-1636

Dated this 17th day of April 2014

/s/Jan Mottaz

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Tim	Silverthorn			1096 Kilburn Street St. Paul, MN 551031029	Paper Service	No	OFF_SL_0-1636_1
Mrg	Simon	mrgsimon@mrenergy.com	Missouri River Energy Services	3724 W. Avera Drive P.O. Box 88920 Sioux Falls, SD 571098920	Electronic Service	No	OFF_SL_0-1636_1
David B.	Sogard	dsogard@minnkota.com	Minnkota Power Cooperative, Inc.	PO Box 13200 1822 Mill Road Grand Forks, ND 582083200	Electronic Service	No	OFF_SL_0-1636_1
Beth H.	Soholt	bsoholt@windonthewires.org	Wind on the Wires	570 Asbury Street Suite 201 St. Paul, MN 55104	Electronic Service	No	OFF_SL_0-1636_1
Wayne	Stenehjem		Office Of Attorney General	Dept. 125 600 E. Boulevard Avenue Bismarck, ND 585050040	Paper Service	No	OFF_SL_0-1636_1

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Robyn	Woeste	robynwoeste@alliantenergy.com	Interstate Power and Light Company	200 First St SE Cedar Rapids, IA 52401	Electronic Service	No	OFF_SL_0-1636_1