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August 3, 2017

VIA ELECTRONIC FILING

Daniel P. Wolf
Executive Secretary
Minnesota Public Utilities Commission
121 Seventh Place East, Suite 350
St. Paul, MN 55101-2147

Re: In the Matter of the Further Investigation into Environmental and Socioeconomic Costs Under Minn. Stat. § 216B.2422, Subd. 3

Compliance Filing, Fourth Affidavit of Anne E. Smith, Ph.D. with Attachment 1

MPUC Docket No. E999-CI-14-643
OAJ Docket No. 80-2500-31888

Dear Mr. Wolf:

At the hearing on July 27, 2017, the Commission ordered Great River Energy, Minnesota Power, and Otter Tail Power Company to make a compliance filing within ten days providing carbon dioxide environmental cost values for additional emission years determined using economic framing assumptions chosen by the Commission. In compliance with that order, attached please find the Fourth Affidavit of Anne E. Smith, Ph.D. along with Attachment 1 to the affidavit, which contains the information required by the Commission.

Thank you for your attention to this matter. Please feel free to contact me at (612) 492-6687 if you have any questions related to this filing or if additional information is required.

Very truly yours,

DORSEY & WHITNEY LLP

/s/ Colin Wicker

Colin Wicker

CW/tjb
Enclosures

cc: Service List (via e-filing) (with encl.)

MINNESOTA PUBLIC UTILITIES COMMISSION
121 Seventh Place East Suite 350
St. Paul, Minnesota 55101-2147

In the Matter of the Further Investigation into MPUC DOCKET NO. E-999/CI-14-643
Environmental and Socioeconomic Costs Under
Minn. Stat. § 216B.2422, Subd. 3

FOURTH AFFIDAVIT OF ANNE E. SMITH, Ph.D.

City of Washington)
)
District of Columbia) ss.

Anne E. Smith, being duly sworn, states the following under oath:

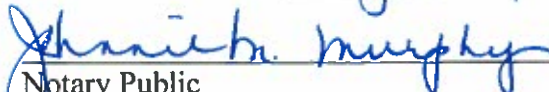
1. I am an economist and Managing Director at NERA Economic Consulting.
2. I have provided testimony on behalf of Great River Energy, Minnesota Power, Otter Tail Power Company (collectively, “the Utilities”), and the Minnesota Large Industrial Group (“MLIG”), in the above-referenced proceeding. I have also previously offered a report titled Expert Report of Anne E. Smith, Ph.D., Senior Vice President, NERA Economic Consulting and dated June 1, 2015 (the “Report”), which was marked as Exhibit 302. The Report included a Table 4 at page 43, and I subsequently submitted an affidavit executed on September 21, 2015, which included as an exhibit a modification to Table 4 from the Report, titled Table 4A. My initial affidavit and Table 4A were marked as Exhibit 307. I submitted a second affidavit on July 24, 2017, which included a Table 4B. The values in Table 4B were calculated based on the July 2015 Technical Support Document from the Interagency Working Group (“IWG”) and were reported in 2015 dollars per net short ton. I also submitted a third affidavit on July 27, 2017 which contained values for emission years 2017, 2020, 2030, 2040, and 2040 determined using specific sets of economic framing assumptions advocated by the Utilities and MLIG.
3. At the hearing on July 27, 2017, which I viewed online, the Commission adopted two sets of economic framing assumptions for its range of values for carbon dioxide. The low end of the range was based on a 5% discount rate, a time horizon ending in 2100, last ton marginal cost, and global values. The high end of the range is based on a 3% discount rate, a time ending in 2300, last ton marginal cost, and global damages. The Commission had 2020 emission year values for those two sets of framing assumptions in hand at the time it adopted them, but not other emission years. Accordingly, near the close of the hearing the Commission verbally ordered the Utilities to make a compliance filing providing emission year values for additional years.

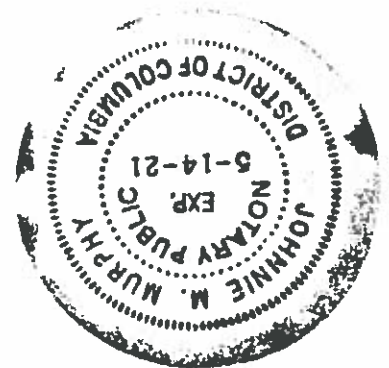
4. I have used the results of the FUND, DICE, and PAGE models (the IAMs used by the IWG) to calculate values for emission years 2020 and 2050 for the Commission's two sets of economic framing assumptions. Then, I used interpolation to arrive at emission year values for the years in between, including 2030 and 2040. I also used extrapolation to determine emission year values for 2017, 2018, and 2019. As I explained in my prior affidavit, I believe using interpolation is reasonable based on the near-linearity of the Federal Social Cost of Carbon ("FSCC") estimates produced by the Interagency Working Group ("IWG") for the years 2020, 2030, 2040 and 2050.
5. Attachment 1 to this affidavit contains two tables. Table A provides the emission year values for 2017, 2020, 2030, 2040, and 2050 determined using both the low and high end sets of framing assumptions. Table B provides emission year values for every year from 2017 to 2050 for both the low end and high end sets of framing assumptions.
6. All the values in Attachment 1 are reported in 2015 dollars per net short ton and were calculated based on the IWG's July 2015 Technical Support Document.

Further your affiant sayeth not.

By: 
Anne. E. Smith

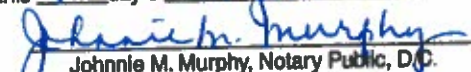
Sworn before me on August 3, 2017


Notary Public



District of Columbia: SS

Subscribed and sworn to before me, in my presence,
this 3rd day of August, 2017


Johnnie M. Murphy, Notary Public, D.C.
My commission expires May 14, 2021.

Attachment 1. ENVIRONMENTAL COST VALUES FOR CO₂
August 3, 2017

The following tables summarize results of NERA’s calculations of ECVs per net ton of change in CO₂ emissions for the two sets of policy assumptions adopted by the Commissioners on July 27, 2017 to establish the low and high ends of the range. The low end of the range is based on 5% discount rate, time horizon ending 2100, last ton marginal cost, and global damages. The high end of the range is one set of framing assumptions used by the IWG, namely 3% discount rate, time horizon ending 2300, last ton marginal cost, and global damages. The full suite of IAM runs have been completed for 2050, using the methodology NERA used for its 2020 values. These runs used the versions of the IAM calculations described in the July 2015 Technical Support Document from the Interagency Working Group (“IWG”). The values for emission years between 2020 and 2050 have been interpolated from the 2020 and 2050 estimates. We also provide \$/net ton estimates for emissions in 2017 by extrapolating back 3 years from 2020 using the 2020-2050 relationship.

Table A provides the values for 2017, 2020, 2030, 2040 and 2050. Table B (on the next page) provides the values for every individual year from 2017 through 2050, to avoid any uncertainty regarding consistent interpolation. All values are stated in 2015 real dollars and as dollars per net short ton of CO₂.

Table A. Summary of Ranges of ECVs for CO₂ Through 2050
(2015\$ per net short ton)

	2017	2020	2030	2040	2050
Low:	\$ 8.44	\$ 9.05	\$ 11.10	\$ 13.15	\$ 15.20
High:	\$ 39.76	\$ 42.46	\$ 51.47	\$ 60.48	\$ 69.48

TABLE A NOTES:

- Low case is based on: 5%, 2100 horizon, last ton, global damages.
High case is based on: 3%, 2300 horizon, last ton, global damages.
- Bolded values (for 2020 and 2050) are based on full suite of IAM runs performed by NERA Economic Consulting consistent with the July 2015 IWG Technical Support Document. All unbolded values are based on linear interpolation/extrapolation from 2020 and 2050 model-based values.

**Table B. Annual Values (2017-2050) of ECVs for CO₂
(2015\$ per net short ton)**

Year	Low	High
2017	\$8.44	\$39.76
2018	\$8.64	\$40.66
2019	\$8.85	\$41.56
2020	\$9.05	\$42.46
2021	\$9.25	\$43.36
2022	\$9.46	\$44.26
2023	\$9.66	\$45.16
2024	\$9.87	\$46.06
2025	\$10.07	\$46.96
2026	\$10.28	\$47.86
2027	\$10.48	\$48.77
2028	\$10.69	\$49.67
2029	\$10.89	\$50.57
2030	\$11.10	\$51.47
2031	\$11.30	\$52.37
2032	\$11.51	\$53.27
2033	\$11.71	\$54.17
2034	\$11.92	\$55.07
2035	\$12.12	\$55.97
2036	\$12.33	\$56.87
2037	\$12.53	\$57.77
2038	\$12.74	\$58.67
2039	\$12.94	\$59.58
2040	\$13.15	\$60.48
2041	\$13.35	\$61.38
2042	\$13.56	\$62.28
2043	\$13.76	\$63.18
2044	\$13.97	\$64.08
2045	\$14.17	\$64.98
2046	\$14.38	\$65.88
2047	\$14.58	\$66.78
2048	\$14.79	\$67.68
2049	\$14.99	\$68.58
2050	\$15.20	\$69.48

TABLE B NOTES:

- Low case is based on: 5%, 2100 horizon, last ton, global damages.
High case is based on: 3%, 2300 horizon, last ton, global damages.
- Bolded values (for 2020 and 2050) are based on full suite of IAM runs performed by NERA Economic Consulting consistent with the July 2015 IWG Technical Support Document. All unbolded values are based on linear interpolation/extrapolation from 2020 and 2050 model-based values.

CERTIFICATE OF SERVICE

In the Matter of the Further Investigation into Environmental and Socioeconomic Costs
Under Minnesota Statute Section 216B.2422, Subdivision 3
MPUC Docket No. E999-CI-14-643
OAJ Docket No. 80-2500-31888

I, Colin Wicker, hereby certify that on this 3rd day of August 2017, on behalf of Great River Energy, Minnesota Power, and Otter Tail Power Company, I electronically filed true and correct copies of the following documents with the Minnesota Public Utilities Commission (“PUC”) and served via electronic filing to all persons indicated on the attached service list:

1. Compliance filing letter addressed to Daniel P. Wolf dated August 3, 2017.
2. Affidavit of Anne E. Smith, Ph.D., with Attachment 1.
3. Service list.

Dated this 3rd day of August, 2017

/s/ Colin Wicker

Colin Wicker

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Minnesota Public Utilities Commission

Staff Briefing Papers

Meeting Date: **July 25 and 27, 2017** Agenda Item # 1**

Company: All Electric Utilities

Docket No. E999/CI-14-643

In the Matter of the Further Investigation into Environmental and Socioeconomic Costs Under Minn. Stat. § 216B.2422, Subd. 3

Issue(s): What action should the Commission take regarding the environmental cost values for PM_{2.5}, SO₂ and NO_x?

Staff: Tricia DeBleeckere | 651-201-2254 | tricia.debleeckere@state.mn.us
Sean Stalpes | 651-201-2252 | sean.stalpes@state.mn.us

Relevant Documents

Petition to Reopen from CEOs: [Memorandum](#), Docket E999/CI-00-1636

[Court of Appeals Opinion](#) from 1997 Order Est. Values, May 19, 1998

[Order Establishing Environmental Cost Values](#), Docket E-999/CI-93-583, January 3, 1997

[Order Reopening Investigation ...](#) Docket E999/CI-14-643, February 10, 2014

[Notice and Order for Hearing](#) Docket E999/CI-14-643, October 15, 2014

[Issues Matrix](#), filed by Xcel on behalf of all parties, Docket E999/CI-14-643, March 1, 2016

Initial and Reply Briefs

Xcel Energy, [Initial Brief](#), March 15, 2016

CEOs, [Initial Brief](#), March 15, 2016

Agencies, [Initial Brief](#), March 15, 2016

MLIG, [Initial Brief](#), March 15, 2016

OTP, [Initial Brief](#), March 15, 2016

Xcel Energy, [Reply Brief](#), April 15, 2016

CEOs, [Reply Brief](#), April 15, 2016

Agencies, [Reply Brief](#), April 15, 2016

MLIG, [Reply Brief](#), April 15, 2016

ALJ Report and Orders

[Order Regarding Burdens of Proof](#), March 27, 2015

[ALJ Report](#), Criteria Pollutants, June 15, 2016

Exceptions and Replies

Xcel Energy, [Exceptions](#), July 15, 2016

CEOs, [Exceptions](#), July 15, 2016

Agencies, [Exceptions](#), July 15, 2016

MLIG, [Exceptions](#), July 15, 2016

Xcel Energy, [Reply Exceptions](#), August 4, 2016

CEOs [Reply Exceptions](#), August 4, 2016

Agencies, [Reply Exceptions](#), August 4, 2016

MLIG, [Reply Exceptions](#), August 4, 2016

Other Document: Background Documents / Reference List

Latest (Annual) Value Update: [Notice of Update Environmental Externality Values](#), Docket E999/CI-00-1636, (June 16, 2017)

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I. Statement of Issue

What action should the Commission regarding the environmental cost values for PM_{2.5}, SO₂ and NO_x?

II. Executive Summary

Upon a petition by environmental groups, the Commission initiated an investigation to update environmental externalities costs previously established pursuant to a statutory mandate by the Commission (in 1997). The Commission considered arguments about which pollutant costs should be updated, ultimately ordering for hearing the consideration of:

- an update of the NO_x and CO₂ values;
- the re-establishment of a value for SO₂; and
- the initial establishment of a value for PM_{2.5}.

The Commission also ordered that the damage cost method of externality valuation should be used, as previously used in the original externalities case. The damage cost quantifies the damage from a marginal ton of a pollutant.

There were fourteen parties who intervened to the docket generally, however, the proceeding was separated into two distinct phases. Phase I was focused on Carbon Dioxide and Phase II was focused on the Criteria Pollutants (NO_x, SO₂, and PM_{2.5}). The Phase II - Criteria Pollutants proceeding had less participation by parties; and largely, the four main participating parties in Phase II were the Department of Commerce and the Minnesota Pollution Control Agency (together, the Agencies), the Clean Energy Organizations (CEOs), Xcel Energy and the Minnesota Large Industrial Group (MLIG). Otter Tail Power (OTP) filed an initial brief, but did otherwise not participate.

To calculate (and/or update) the externality values, the parties employed similar approaches, 1) they selected a geographic area in which they calculated baseline emissions (based on known air quality data), 2) then they modeled the level of increased air quality pollution expected from the addition of a new power plant at certain locations, 3) took data that provided the expected impacts to resources based on the increase in pollutants in certain geographic regions – here referred to as the concentration-response function, then, last, 4) multiplied the amount of damage by certain cost values, largely a value referred to as the value-of-statistical life (VSL).

Each party took differing approaches to how they calculated each of the damages by pollutants; NO_x, SO₂ and PM_{2.5} all have direct impacts from their release, however, secondary PM_{2.5} can also form from chemical formations from NO_x and SO₂ with other chemicals. Pollutant interactions and secondary pollutant-based formation and impacts are factored in to differing degrees by parties in their final recommendations.

The Administrative Law Judge (ALJ) released her report on June 15, 2016 recommending the Commission address the matter by answering the following four questions, in part based upon the factors that will have a large impact to the ultimate values; she provided a recommendation on each of the questions posed:

What is the most appropriate value for the Value of Statistical Life (VSL)?

\$7.7 million.

What is the most appropriate concentration-response function?

6.8 percent, but if the Commission would like to adopt a range to address uncertainty, the recommended range was 6 to 7.3 percent.

What [emission] sources and source locations should be included?

Two options are provided for the Commission's consideration (with additional detail not listed here):

- a. Use of, and expansion of, Xcel's approach of a three tier model (urban, fringe, and rural) to a five or six tiered model (to incorporate more variations on the rural category) and use of the CAMx model, as practicable, or,
- b. Use of an 87 Minnesota county configuration, but only out of state sources that reflect active electric generating units in the out-of-state locations (with some exclusions) and use of the AP2 model.

What is the proper geographic scope of damages?

The ALJ did not provide a recommendation on the geographic scope of damages; she determined it to be a policy matter to be decided by the Commission. She noted that if the Commission chooses to include the contiguous US or some substantial area outside of Minnesota in the externalities costs, the recommendation is to use the CAMx model as it is the most reliable model to calculate those costs.

III. Background

Minn. Stat. § [216B.2422, Subd. 3](#). required the Commission, to the extent practicable, quantify and establish a range of environmental costs associated with each method of electricity generation. The law requires each utility to use the values in conjunction with other external factors when evaluating resource options in all proceedings before the Commission.

To address its obligation to establish interim environmental cost values by the March 1, 1994 statutory deadline, the Commission established interim cost values in 1994 and final

values on January 3, 1997.¹ Values established were for Sulfur Dioxide (SO₂), Carbon Monoxide (CO), Carbon Dioxide (CO₂), and Nitrogen Oxides (NO_x), Lead (Pb), and particulate matter less than 10 microns in diameter (PM₁₀).

On December 14, 2000, the Commission initiated an investigation into whether the environmental cost values should be updated or expanded, and whether and how socioeconomic costs can be compared for all electricity generation sources. As a result of the investigation, the Commission concluded it would update the cost values by adjusting them to account for inflation. The cost values were updated annually thereafter, except in 2006. Ultimately, the Commission determined that socioeconomic costs were case specific and it would not set explicit values for socioeconomic costs.²

On October 13, 2013, the Izaak Walton League of America – Midwest Office, Fresh Energy, the Sierra Club, the Center for Energy and the Environment, the Will Steger Foundation, and the Minnesota Center for Environmental Advocacy filed a motion to reopen the docket - requesting that the Commission update its cost values for CO₂ and NO_x emissions, and establish a cost value for particulate matter less than 2.5 microns in diameter (PM_{2.5}), and reestablish a value for SO₂.^{3, 4}

On February 10, 2014, the Commission found that the scientific and evidentiary support for the existing values had been reasonably called into question, and reopened the investigation. The Commission sought additional input into the investigation scope, requesting the Department of Commerce and the Pollution Control Agency convene a stakeholder group for the purpose of making recommendations regarding whether additional greenhouse gases should be considered.^{5, 6}

On October 15, 2014, the Commission had considered the Agencies' report and it issued its *Notice and Order for Hearing*⁷ initiating formal evidentiary hearings to reevaluate and update

¹ [Order Establishing Environmental Cost Values](#), Docket E-999/CI-93-583 (January 3, 1997)

² Order Updating Externality Values and Authorizing Comment Periods..., Docket E999/CI-00-1636 (May 3, 2001)

³ The Commission concluded in its January 3, 1997 Order that, after 2000, a federal cap-and-trade program would fully internalize the environmental costs of SO₂ emissions. Since 2000, the Commission's cost value for SO₂ has been \$0.

⁴ Clean Energy Organizations acknowledged in their petition that all of the pollutants for which the Commission quantified cost values in Docket No. CI-93-583 have potential for significant environmental damage, however for the purposes of this Motion, because SO₂, NO_x, PM_{2.5} and CO₂ dominate fossil-fuel-fired air emissions, CEOs argued that narrowing the update to the Commission's cost values for these four pollutants is appropriate and outlined the basis for updating the SO₂ value from zero and creating a value for PM_{2.5}. *Docket 93-583, October 9, 2013 Motion to Reopen: [Memorandum](#) in Support of CEOs Motion to Update Externality Values for use in Resource Decisions.*

⁵ Order Reopening Investigation and Convening Stakeholder Group to Provide Recommendations for Contested Case Proceeding, Docket No. E-999/CI-00-1636 (February 10, 2014).

⁶ The stakeholder group was only able to come to consensus on three issues: 1) the criteria that the Agencies developed to assess potential investigation processes were appropriate; the best and most credible estimates for externality values should be developed; and, 3) there should be a high degree of transparency in the analyses.

⁷ [Notice and Order for Hearing](#), Docket E-999/CI-14-643, (October 15, 2014).

the environmental cost values, specifying the issues for hearing as:

- 1) The appropriate values for CO₂ under Minn. Stat. 216B.2422, subd. 3 and whether the Federal Social Cost of Carbon is reasonable and the best available measure to determine the environmental cost of CO₂ and if not, what measure is better supported by the evidence, and,
- 2) The appropriate values for PM_{2.5}, SO₂, and NO_x under Minn. Stat. 216B.2422, subd. 3.

Additionally, the Commission specified that parties should use the damage cost approach to valuing environmental costs and noted it preferred reduced form modeling for use in this case (and directed any consultant in this case to use reduced form modeling).

IV. 1997 Decision Establishing Values

In its 1997 Order Establishing Cost Values (1997 Externalities Order), the Commission adopted the values proposed by the ALJ and provided guidance on how those values were to be utilized, at page 5⁸:

“The range of environmental costs adopted by the Commission in this Order will now be used by utilities, in conjunction with other external factors (including socioeconomic costs) when evaluating and selecting resource options in all proceedings before the Commission, including resource plan and certificate of need proceedings. ... These values will not apply to decisions regarding the dispatch of electric power from existing facilities.

The Commission established values were originally as follows:

Table 1. 1997 Commission Established Environmental Cost Values

<i>\$/ton</i>	Urban (Low to High)	Metro-Fringe (Low to High)	Rural (Low to High)	Within 200 Miles of MN (Low to High)
SO ₂ *	112-189	46-110	10-25	10-25
PM10	4462-6423	1987-2286	562-855	562-885
CO	1.06-2.27	0.76-1.34	0.21-0.41	0.21-0.41
NO _x	371-978	140-266	18-102	18-102
Pb	3131-3875	1652-1995	402-448	402-448
CO ₂	.30-3.10	.30-3.10	.30-3.10	.30-3.10

*Until the year 2000, then all SO₂ values were to be zero as it was determined that the Federal cap and trade program would internalize the externality values.

The 1997 Externalities Order also discussed several other issues that are again relevant for the Commission’s consideration at this time as they are argued in some form in this current proceeding, each discussed in more depth in the discussion section below.

⁸ [Order Establishing Environmental Cost Values](#), Docket E-999/CI-93-583 (January 3, 1997)

V. Current Values

After the values were established, the Commission later found that the values should be periodically updated for inflation using the Gross Domestic Product Implicit Price Deflector (GDPIPD) (roughly annually) and the last update occurred in June 2017⁹. The following are the most current values in use at the Commission:

<i>\$/ton</i>	Urban (Low to High)	Metro-Fringe (Low to High)	Rural (Low to High)	Within 200 Miles of MN (Low to High)
SO ₂	0-0	0-0	0-0	0-0
PM10	6,665.65-9594.88	2,968.25-4,311.21	839.52-1,277.21	839.52-1,277.58
CO	1.59-3.38	1.13-2.00	0.30-0.61	0.30-0.61
NO _x	554.22-1,460.97	209.13-397.35	26.89-152.37	26.89-152.37
Pb	4,677.19-5,788.60	2,467.82-2,980.19	600.52-669.22	600.52-669.22
CO ₂	0.44-4.64	0.44-4.64	0.44-4.64	0.00-0.00

VI. Uncertainty

Staff highlights some framing ordering points from the 1996 ALJ Report that the Commission ultimately adopted. Staff believes these are relevant in light of some parties' arguments regarding what the Commission 'must' do (or not do) in combination with some of the (current) ALJ's conclusions regarding the information on this record. Additionally, staff notes that the Commission will need to determine to what extent considerations in the previous decision apply today.

Uncertainty Generally

31. A major issue in this proceeding is the approach that should be taken in the face of uncertainty. At some point, the degree of uncertainty associated with a proposed value becomes so great that there is insufficient evidence to meet the preponderance standard, and the value cannot be adopted.

32. The quantification of environmental costs necessarily involves the consideration of scientific evidence that generally does not provide definitive answers, forcing the Commission to make inferences or judgments about the environmental costs in question.

33. A variety of economic methodologies can be employed to transform the scientific evidence of costs into dollar figures, and these methodologies produce varying estimates. Whatever methodology is applied, it necessarily involves making judgments and estimates in the face of some uncertainties.

⁹ See [Notice of Update: Environmental Externality Values](#), Docket E999/CI-00-1636, (June 16, 2017)

34. When the Commission adopted the interim values, it noted:

The statute implemented here requires the Commission to establish a range of values. Using a range appropriately acknowledges the uncertainty attending externality values. (Order Establishing Interim Environmental Cost Values (March 1, 1994) at pg. 9.

Use of Ranges to Address Uncertainty

From the 1996 ALJ Report:

The ALJ agrees with the Commission that using ranges, rather than a precise number, more accurately expresses the reality of this whole process, and the reality of the record created in this proceeding – that any number recommended herein must be recognized as an approximation, which is subject to refinement as new and better data become available. However, the resource planning process involves many other uncertainties as well, so there is no reason to demand precision for this factor. (Citations omitted)

From the Commission's Order Establishing Values, at 15:

...Quantification of environmental values necessarily involves the consideration of scientific evidence that generally does not provide definitive answers. The statute implemented here requires the Commission to establish a range of values. Using a range of values appropriately acknowledges the uncertainty attending the quantification of environmental costs. Using a range also permits the testing of resource plans for sensitivity to changes in environmental values.

Adoption of Values – Conservative Approach

1996 ALJ report at 17-18.

The ALJ recommends that the Commission adopt conservative values in this proceeding because, despite the attention utility regulatory commissions have recently afforded environmental impacts, the quantification to environmental costs is still in its infancy. While using reasonably accurate estimates is better than imputing no values, not all estimates are better than zero. For instance, valuing an impact at more than twice its "true" residential damage may lead to a worse allocation of resources than imputing no value. In other words, the possibility of utilities paying more for resources than their environmental benefits justify is just as bad as paying less than their benefits justify. Given the current uncertainty regarding the estimation process, overestimating the damages is a distinct possibility. The Commission would then be forced to order reductions in future proceedings. This "yo-yo" pattern of values would be more confusing and disruptive than a pattern of gradual increases. A better alternative is to err on the side of conservatism

initially, then increase the values gradually if better information in the future confirms the need for higher values.

VII. Order Reopening Matter

In 2013, the CEOs filed a motion requesting that the Commission update its cost values for CO₂ and NO_x emissions, to establish a cost value for particulate matter less than 2.5 microns in diameter (PM_{2.5}), and to reestablish a value for SO₂, arguing that the current values for some pollutants do not reflect the current science and underestimate the costs of pollution.

When it re-opened the investigation, before it referred the matter to the Office of Administrative Hearings (OAH), the Commission directed the Department of Commerce to convene a stakeholder group to provide further recommendation on the scope of the investigation. After a several month process, the Department ultimately reported that the stakeholder group it had convened was unable to come a consensus about several scope related issues, however, it provided the following recommendations (that was not a stakeholder group recommendation)¹⁰:

- Other greenhouse gases should not be included in the damage estimates (only CO₂).
- While the geographic scope of the application of the CO₂ externality value should not be revisited as the Commission ordered (that damages should be calculated globally, but should not apply outside of Minnesota), the Agencies noted that the criteria pollutants were different:

Criteria pollutant (SO₂, NO_x, PM_{2.5}) emissions, however, have local and regional effects. Most (but not all) of the impacts of emissions of these pollutants in Minnesota will occur in Minnesota. Emissions of criteria pollutants within Minnesota have some impacts in neighboring states, particularly those generally downwind from us, to the east and southeast. Similarly, emissions in states that border us will have impacts within Minnesota. This was the reason the Commission originally established that externality values would be applied to criteria pollutants emitted from electric generators located not just within Minnesota but within 200 miles of the state's borders. Given this reasoning, the Agencies recommend that in estimating externality costs for criteria pollutant emissions from Minnesota electric generators, all damages should be considered, not just those within Minnesota.¹¹

¹⁰ Department of Commerce [Stakeholder Report](#), Docket E999/Ci-00-1636, June 10, 2014

¹¹ Staff notes that this statement from the DOC exemplifies the disagreements on the emission source locations and the geographic scope that are discussed later in the paper; here the DOC seems to argue that only emissions from *Minnesota* generators should be considered, while all damages (regardless of the location) be considered. Later in the proceeding, the Agencies advocated for estimating the costs of any potential generation resource that was 'within 200 miles and that would provide electricity to MN customers'.

- Regarding whether non-health impacts should be taken into consideration will depend on the evidence and whether parties have credible and defensible methods for quantifying those impacts.
- For criteria pollutants, a photochemical modeling approach should be taken to determine the most credible externality values; however if the photochemical modeling approach is too time consuming or financially restrictive, then a reduced form modeling approach would be the next best method.

In light of the Agencies' recommendation, the Commission referred the matter to the OAH for contested case hearings on the issue of the appropriate values for SO₂, PM_{2.5}, and NO_x.¹² The Commission "require[d] parties in the contested case proceeding to evaluate the costs using a damage cost approach, as opposed to (for example), market-based or cost-of-control values." The Commission was silent on the geographic scope for criteria pollutants.

The Commission approved the Department's request to hire a consultant and further stated that: "having considered the relative merits of damage modeling approaches discussed by the Agencies, [it] prefers reduced-form modeling in this case. While the photochemical modeling approach may offer the greatest precision, its complexity renders it slower and more expensive than reduced-form modeling. As several participants acknowledged, reduced-form modeling will also provide credible results as a next-best alternative to photochemical modeling."

VIII. Process to Calculate Damage Values

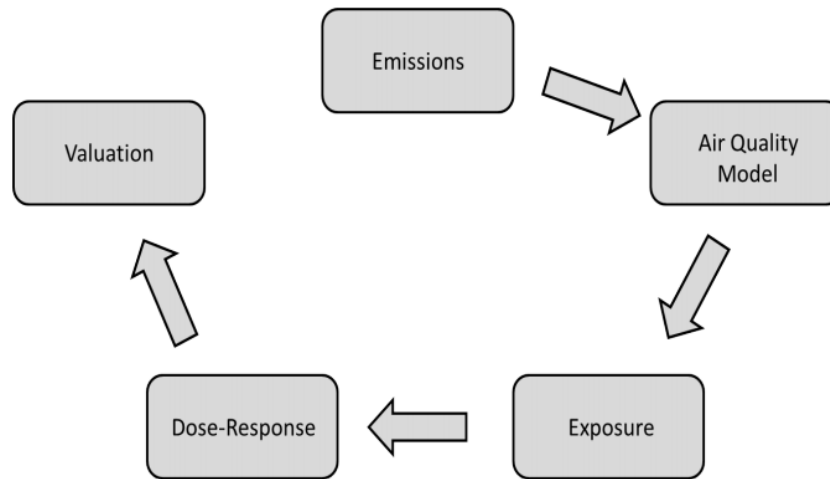
At a very simplified level, the steps employed by parties to calculate externality costs was similar to the process outlined by the Department in their stakeholder report¹³. However, the inputs and metrics used by each party to calculate each step was not. N. Muller's Direct Testimony provides the following general process used to calculate externality damage costs¹⁴:

¹² [Notice and Order for Hearing](#), E999/CI-00-1636, CI-14-643, October 15, 2014

¹³ Department of Commerce [Stakeholder Report](#), Docket E999/CI-00-1636, June 10, 2014

¹⁴ [Muller Direct Testimony](#), Docket E999/14-643, August 5, 2015, page 4-6.

Figure 1: Structure of Integrated Assessment Model for Air Pollution.



The approach typically employed to estimate the impacts from air pollution emissions is referred to as the “damage function” approach. The basic idea is to construct a computerized model that accomplishes the following tasks:

1. documents where emissions occur and in what quantities
2. emulates how particular pollutants move or disperse through the environment,
3. estimates the extent to which human populations and other receptors (e.g., crops) are exposed to this pollution,
4. links exposure to specific health and other impacts, and
5. monetizes those impacts.

The most common way these tasks are accomplished is through the use of integrated assessment models (IAMs). Such models simulate the relationship between emissions and impacts. A standard air pollution IAM consists of five modules, one for each step of the analysis. The steps in the model include: emissions, air quality modeling and ambient concentrations, exposures, human health and environmental impacts, and monetary valuation. These steps are shown in figure 1. IAMs have been widely used to evaluate air pollution policies by academics and policymakers for many years

The first step documents where and in what amounts emissions occur. The second step, air quality modeling, connects emissions to estimates of ambient pollutant concentrations (i.e., the concentration of harmful pollutants in the air). With concentration estimates produced by the model, the next stage tabulates exposures. This phase combines the predicted concentrations with data on entities that are sensitive to contact with ambient pollution. The exposure stage requires spatially detailed data on populations that have been shown to exhibit sensitivity to air pollution exposure, for example, human populations. Exposures are then translated to physical environmental

and health effects using dose-response functions. Finally, these effects are reported in monetary terms.

IX. Office of Administrative Hearings Proceeding

The Commission referred the matter to the OAH and largely had participation from the four main parties, the Agencies, CEOs, MLIG, and Xcel Energy. Otter Tail Power (OTP) filed an initial brief, but did otherwise not participate.¹⁵ Judge LauraSue Schlatter was assigned. Each party sponsored the following witnesses; more detail on each is provided in the ALJ's Report at Attachment A.

Party	Witness	Background
CEOs	Dr. Julian Marshall	Associate Professor of Environmental Engineering
	Dr. David R. Jacobs	Professor of Epidemiology and Community Health
	Dr. Stephan Polasky	Regents Professor of Ecological and Environmental Economics
Agencies	Dr. Nicholas Z. Muller	Associate Professor of Economics
Xcel	Dr. William H. Desvousges	Independent Consultant
	Mr. Richard A. Rosvold	Air Quality Manager for Xcel
MLIG	Dr. Roger O. McClellan	Independent Consultant

X. ALJ Requested Memos or Topics to Brief

Judge Schlatter requested that parties brief on two subjects, the first, related to the burden of proof, was applicable to both phases, Phase I: Carbon Dioxide and Phase II: Criteria Pollutants. The second, on the geographic scope, related only to criteria pollutants, as the question on the geographic scope of carbon dioxide was addressed (and required to be global) by Commission order.¹⁶

A. Burden of Proof Memo

Ultimately the ALJ outlined eight points related to the burden of proof in her March 27, 2015 *Order Regarding Burdens of Proof*¹⁷. The ALJ reviewed the previous externalities case history and the 1998 Minnesota Court of Appeals opinion¹⁸, and concluded generally, her parameters for parties proposing new values, arguing for retention of the existing values, arguing for the impracticability of the existing values, and arguing against new values. She stated that any party proposing a new environmental cost value or proposing to retain the existing environmental cost value has the burden of showing, by a preponderance of the evidence, that the cost value being

¹⁵ See OTP Initial Brief – OTP largely argued for use of the values based on CAMx, that county-level specificity is unnecessary (and provide false precision), that the geographic scope should be limited to Minnesota, and that application of the values should only pertain to sources within 200 miles, and not to sources in counties within 200 miles of Minnesota (as Dr. Muller modeled). OTP largely supported Xcel's proposal.

¹⁶ [Notice and Order for Hearing](#), E999/CI-00-1636, CI-14-643, October 15, 2014, at 4.

¹⁷ See [Order Regarding Burdens of Proof](#), March 17, 2015, at 4.

¹⁸ See [Court of Appeals Opinion](#), XC-97-1391, May 19, 1998

proposed is reasonable, practicable, and the best available measure of the pollutant's cost. The ALJ noted that the existing values are assumed to be practicable.

B. Geographic Scope – Legal or Policy Question

Specifically pertaining to the Phase II – Criteria Pollutant proceeding, the ALJ requested that all parties brief the issue of geographic scope of damages, she requested (paraphrased):

Does Minn. Stat. 216B.2422, subd. 3, require (assuming it is practicable to model) the Commission to include damages nationally, calculated based on the national impact? Does recent case law or anything else prohibit it? Or is it a policy question for the Commission to decide?¹⁹

Of note, in the 1997 Externalities Order, the Commission found that damage costs would be geographically limited (generally) to Minnesota (this is discussed in more detail below)²⁰.

With respect to all the pollutants quantified in this Order except CO₂, for which global damages are addressed below, the Commission finds that the record supports finding in-state damages from a generating plant located up to 200 miles from the state border, but that it is not practicable (on the current record) to establish values for damages caused by emissions originating in plants beyond that point. Accordingly, the Commission has set values for emissions originating within the 200 mile band, as recommended by the Department and the ALJ. Environmental cost values for emissions from generating sites located beyond the 200 mile band are deemed to be zero.⁶

The State of North Dakota argued that Minnesota's externalities statute cannot be interpreted as extending to electric generation facilities located beyond Minnesota's boundaries because to do so would violate the U.S. Constitution. The Natural Gas Utilities countered that failure to apply the statute to out-of-state generation would give that generation a significant advantage over Minnesota-based generation during the resource planning process. The Commission notes that the statute on its face does not differentiate between in-state generation and out-of-state generation and, as noted previously, the Commission is not in a position to decide Constitutional claims. The Commission, therefore, has executed its mandate under the statute to quantify all generation-related damages occurring in Minnesota, regardless of the location of the generating site in question, to the extent that it is feasible to do so.

Additionally, upon reopening, and after initial public comment, the Commission agreed to investigate the environmental and socioeconomic costs of electricity generation for SO₂, PM_{2.5},

¹⁹ Evidentiary Hearing Transcript, Vol. 8, at pg. 157-159, Docket E999/CI-14-463

²⁰ [Order Establishing Environmental Cost Values](#), Docket E-999/CI-93-583 (January 3, 1997)

NO_x, and CO₂. Specifically, the order discussed the geographic issues relating to CO₂, but was silent on criteria pollutants^{21,22}.

The Commission will reopen its investigation as requested by the Clean Energy Organizations and will investigate the appropriate range of externality values for PM_{2.5}, SO₂, NO_x, and CO₂. The investigation will not reconsider the geographic limitations of its environmental cost value for CO₂.²³

Ultimately, in the ALJs recommendation, she concluded that the matter was a policy-based question for the Commission. She did not provide a recommendation. This issue is discussed in more depth below under contested issues. The parties' positions provided to the ALJ in their briefs were as follows:

1. Xcel: Policy Question for the Commission to Determine

Xcel argued that the statute is silent on the geographic scope of damages; Xcel conducted a legislative history search in which it found no guidance on whether the statute was intended to address whether environmental costs should be measured based on their impact within Minnesota or nation-wide. Xcel argued that the Commission found in the original decision that calculating damage costs of criteria pollutants only with Minnesota; that decision can be interpreted as long-standing Commission precedent and interpretation on the statute. Xcel noted that courts give deference to administrative interpretations of statutes, and the level of deference increases when the agency is construing a statute which it administers and in which the construction is long-standing, and further, that any changes to a long-standing agency interpretation must be supported by substantial evidence in view of the entire record submitted.²⁴ Ultimately, Xcel believes it is a policy question for the Commission.

2. CEOs: Geographic Scope Must be National Pursuant to Statute and the Previous Order

The CEOs argued that 1) it is practicable to calculate national damages and 2) national damages are *required* by the statute by a plain-language reading the geographic scope of damages and 3) the Commission's previous determination requires a national-scope of geographic damages. CEOs argued that the only limiting consideration in the statute is the *practicability*, and, in the previous proceeding, practicability meant that damages were limited to a Minnesota Domain because there was no data with which to calculate damages using a different scale. CEOs argue that the record evidence shows, and proves, that the data is now available and that the impacts extend beyond Minnesota. CEOs argue that it is not the Commission's place to determine this

²¹ [Order Reopening Investigation and Convening Stakeholder Group...](#) Docket E999/CI-00-1636 (February 10, 2014)

²² [Comments](#) - State of North Dakota, Docket E999/CI-00-1636 (November 7, 2013)

²³ Reopening Order at 5: "The Commission will not, as a part of this investigation, reexamine its earlier decision not to apply the CO₂ environmental cost values to facilities in North Dakota.⁵ The Commission concluded in 1997 that important factors—the cost/benefit balance of applying CO₂ values to North Dakota facilities, and interstate comity—weighed against applying CO₂ cost values to North Dakota facilities. The Commission's evaluation of those factors, and its conclusion as it concerns CO₂ values, have not changed."

²⁴ Xcel's Reply Brief, at 5-6.

policy decision; that it was up to the legislature who did not specify ‘Minnesota-damages alone’.²⁵ CEOs argue (citing the Commission’s 1997 Order Establishing Values) that the Commission itself intended to calculate actual damages (regardless of scope).²⁶

In its reply exceptions, the CEOs argued that the statute requires only that the Commission quantify the damages from emissions and sources generated to produce power for Minnesota and that the impacts do not need to be here, so long as the power is used here. CEOs argued to do otherwise would not be fulfilling the statutory requirement and would be arbitrary.²⁷

3. Agencies: Policy Issue for the Commission, but Record Shows it is Practicable to Quantify

The Agencies noted that the statute here did not define the term ‘environmental costs’ and by not defining the term the legislature left to the Commission’s discretion the definition of ‘environmental costs to be quantified’. The Agencies note the constraints on the Commission’s “exercise of its discretion are that (1) the decision must establish a range of costs; (2) it must be practicable to quantify and establish the range of costs; and, (3) the decision needs to be supported by the evidentiary record.”²⁸ The Agencies argue that their witnesses prove that it is imminently practicable to quantify a range of damages for each of the pollutants at issue in this docket. Specifically addressing the arguments made regarding use of the previous Commission’s order as precedent, Dr. Muller argued that there is ‘no need to be consistent with modeling limitations that existed in the 1990’s.’²⁹

4. MLIG: Geographic Scope Should be Local

The Minnesota Large Industrial Group argued that consideration of damages should be held to local geographic scope as there is uncertainty in the damage calculation for both Minnesota and the 100 mile area surrounding it, and uncertainty becomes significantly greater as the distance from the source increases.³⁰

XI. Parties Proposal and Position Overview

Staff refers Commissioners to Xcel’s Initial Brief at page 12 for a summary of each party proposal; while notably, this is one party’s summation of other proposals, and should be read for bias and opinion, staff believes it does a reasonable job of capturing the high-level positions and considerations of each party.³¹ For the remaining discussion, staff uses the ALJ report as a starting point, and discusses party exceptions her conclusions.

²⁵ CEO’s Initial Brief, at 26-29.

²⁶ CEO’s Initial Brief, at 29.

²⁷ CEOs Reply Exceptions.

²⁸ Agencies’ Initial Brief, at 56

²⁹ DOC Ex. 813 at 3, Agencies’ Reply Brief at 24.

³⁰ MLIG Initial Brief at 48.

³¹ Xcel Initial Brief, at 12.

Parties used various models, model inputs, pollutant interaction considerations (between NO_x, SO₂, PM_{2.5} and O₃), emission sources and source considerations, differing resource impacts, and levels of reaction to those resource as well as the financial values imposed on each consideration.

Parties values ranges also varied, significantly, and are as follows:

<i>All values are per \$/short ton</i>	Agencies (2011 \$) Low-High (County Averages)	CEOs (2015 \$) Generic Values Low-High Range**	MLIG
PM _{2.5}	\$26,012-140,102/ton ³²	\$125,000-218,000/ton	Existing Value
NO _x	\$1,183-6,219/ton	\$14,000-24,000/ton	Existing Value
SO ₂	\$11,818-64,180/ton	\$16,000-28,000/ton	Existing Value

** See: Marshall Direct, Schedule 3 for the recommended county-by-county values – CEOs do not recommend averaging or combining values as is done here.

Xcel Recommended Values \$/short ton			
	Rural	Metro-Fringe	Urban
PM _{2.5}	\$3,437-8,441	\$6,450-\$16,078	\$10,063-25,137
NO _x	\$1,985-6,370	\$2,467-7,336	\$2,760-7,893
SO ₂	\$3,427-8,352	\$4,543-11,317	\$5,753-14,382

Largely, as noted by parties and the ALJ, the inputs which have the largest impact to the final recommended values are the values proposed for the concentration-response function and the value of statistical life – however, the geographic scope of damages, the emission source locations, as well as other factors contribute to various degrees. Xcel argued that while those appear to be the largest contributors, inaccurate modeling inputs or parameters can also have significant impacts to the ultimate values.³³

XII. ALJ Recommendation and Report

Judge Schlatter made several conclusions and recommendations to the Commission. In short, she recommended specific values for the VSL and concentration response function, provided two options to pursue to recalculate values using modifications of the party's approaches to the modeling of emission sources, and recommended the Commission determine the appropriate geographic scope of damages. Generally, she recommended:

What is the most appropriate value for the Value of Statistical Life (VSL)?
\$7.7 million.

What is the most appropriate concentration-response function?

³² Agency's values are average marginal damages across sources.

³³ Xcel Initial Brief, at 24.

6.8 percent, but if the Commission would like to adopt a range to address uncertainty, the recommended range was 6 to 7.3 percent.

What [emission] sources and source locations should be included?

Two options are provided for the Commission's consideration (with additional detail not listed here):

- a. Use of, and expansion of, Xcel's approach of a three tier model (urban, fringe, and rural) to a five or six tiered model (to incorporate more variations on the rural category) and use of the CAMx model, as practicable; or,
- b. Use of an 87 Minnesota county configuration, but only out of state sources that reflect active electric generating units in the out-of-state locations (with some exclusions) and use of the AP2 model.

What is the proper geographic scope of damages?

The ALJ did not provide a recommendation on the geographic scope of damages; she determined it to be a policy matter to be decided by the Commission. She noted that if the Commission chooses to include the contiguous US or some substantial area outside of Minnesota in the externalities costs, the recommendation is to use the CAMx model as it is the most reliable model to calculate those costs.

XIII. Discussion of Contested Issues and Exceptions

A. Framing of Discussion and Commission Considerations

Staff discusses the ALJ Conclusions of Law by topic, under the headings of each contested issue. Within each, staff summarizes the ALJ's Conclusions, Recommendations, and exceptions. Staff provides additional context, as needed. The ALJ structured her Conclusions in the following manner: 1) Models; 2) Spatial Sensitivity; Emission Sources and Source Locations; 3) Geographic Scope of Damages; 4) Value of Statistical Life and Concentration Response Function; and 5) Ambient Concentrations of PM_{2.5} Relative to Mortality. But, as stated above, suggested the Commission tackle the discussion by addressing VSL, then concentration response function, then emission sources, and last, geographic scope.

The Commission could either follow the outline below for deliberations or consider some other approach; currently the outline is ordered in a manner in which the Commission would be largely considering the record evidence as available in this docket (and not making initial policy determinations on the geographic scope or on emission source locations). This is based on an assumption that both the emission source locations and/or geographic scope of damages are science-based decisions bound by the evidence on this record. However, if the Commission believes that the emission source locations and/or geographic scope of damages is an preliminary

policy or precedence issue, that can be clarified regardless of this record and that decision could drive the consideration and order of later questions.

Parties appear to disagree on (or simply interpret differently) the basis for the Commission's last decision – whether previous restrictions to Minnesota were due to the Commission's intent to only consider damages within Minnesota (as a matter of policy), or if it was because the impacts of the pollutants were only proven to occur in scope reasonably surrounding Minnesota (as a matter of evidence and modeling limitations).³⁴

In this current proceeding, the Commission did not address questions of geographic scope of criteria pollutants in its order for hearing. Due to the interrelated nature of the emission source discussion and the damage value geographic scope language of the previous order, staff believes it was unclear to parties whether the Commission was intending today to revisit (or not) that questions.

Ultimately, this factors into this proceeding in that parties used models that aligned with their interpretations. Xcel limited damage calculations and emission sources to an area relatively surrounding Minnesota using a more complex, photochemical model (which, generally, would be assumed to have increased accuracy and precision but takes longer to run model iterations, and therefore is arguably limited in its ability to model multiple emissions sources and geographic scope).

The Agencies and CEOs believe that damages should be included as far as they are calculable, and therefore they used a more simplistic, reduced form model (which uses more simple calculations in order to capture a broader geographic scope under multiple iterations).³⁵

Beyond what carry-over the original order has on this current proceeding, the ALJ questioned whether the issue of geographic scope of damages was a matter of law or policy (as discussed above). Ultimately, the ALJ found it was a policy issue to be decided by the Commission.

On another matter, staff recommends the Commission should also consider whether the outcome of this instant decision should (or needs to be) the adoption of externality *values* based upon the record evidence provided by parties before it (and whether that is possible with this record), or if as the ALJ recommends, that the Commission instead adopt/order a modeling approach that would require additional modeling and calculation of values by some party and require additional time and cost. The ALJ Report presumes the ordering of additional modeling (emission sources and geographic scope) and/or recalculation of later inputs (VSL or the concentration response function). And with the options before the Commission, at a minimum,

³⁴ Agencies Initial Brief, at 23-24. "[Dr. Desvousges] had attempted to replicate the study area of the original environmental cost study performed in the 1990s. ... Dr. Muller disagreed with the use of the grid-box approach for the current investigation, explaining that there is no scientific basis for limiting damages considered to this small area. ... There is no need to be consistent with modeling limitations that existed in the 1990's."

³⁵ The Commission required the Agency's contractor to use reduced form modeling. See [Notice and Order for Hearing](#) Docket E999/CI-14-643, October 15, 2014.

re-calculation could be a likely outcome, as several considerations (inputs to the models) could be modified by the Commission. Differing levels of re-calculation would require variable levels of time and effort. Staff believes rerunning the emissions modeling, depending on the scope and scale of what is deemed appropriate, could be intensive depending on the models and inputs. Additionally, there is likely disagreement between parties on what type of post-modeling process would be required (comment period, additional hearings, etc.) And ultimately, staff questions whether or not the Commission should adjust party proposals and inputs or whether it should evaluate the proposals before it, as-is.

B. Party Positions on ALJ Report (Generally)

All Parties provided exceptions on the ALJ Report, while there were some substantial exceptions, many parties took issue with facts or deference given to record evidence. Staff focuses on areas of general disagreement in the party positions below, and outlines specific exceptions in each section.

a. Agencies

The Agencies provide exceptions to the ALJ report, and support her recommendation to use the AP2 model however, they note that use of the CAMx model, if adopted by the Commission would be acceptable if the model assumptions and parameters (geographic scope of damages (national), concentration-response function, and VSL) were appropriate. In short, the Agencies recommend adoption of the ALJ report with the exceptions provided by the Agencies.

b. CEOs

The CEOs argued that the ALJ Report failed to follow the best science in the record. Specifically, the CEOs argued that the ALJ made several flaws in her analysis that do not follow the record, and therefore they concluded that the Commission should order 1) the calculation of a national scope of damages; 2) order the concentration-response function be set directly from the best available science; 3) order that the modeling adopt the VSL that has been created, vetted and used by the EPA; and 4) order modeling that reflects geographic and source-type diversity.

c. Xcel

Xcel generally agrees with the ALJ's report with limited exceptions. First, Xcel proposed an amendment to ALJ Recommendation 1; that the Commission should at the outset find that the proper geographic scope is in Minnesota and within 100 miles.³⁶ Staff does not discuss this recommendation further as the ALJ's initial recommendation was a framing consideration, the Commission will determine how to answer this question as it proceeds.

On other matters, Xcel agrees with the ALJ in recommending the CAMx model, disagrees with the recommendation to use the AP2 model, disagrees that modification to Xcel's 3-tier structure is necessary (nor that an 87-county approach could be reasonable) and agrees with the ALJ on

³⁶ Xcel Initial Exceptions at Attachment 1.

the conclusions regarding the (in)accuracy of other parties' modeling. Xcel's concise summary of their opinion of the ALJ report is available at their Initial Exceptions at page 42.

d. MLIG

MLIG takes strong exception to essentially the entirety of the ALJ Report. MLIG argued that the Commission should reject part of the ALJ's burden of proof memo that imposed a burden of proof on parties that object to changes in the existing values and do not advance new values as they claim it is contrary to rule).³⁷ MLIG also furthered that the ALJ took a new reading of the externalities statute in her interpretation that there doesn't need to be a causal link, only an association (see ALJ Report Memorandum). Last, MLIG took several exceptions to her finding of damages at a level below 12 $\mu\text{g}/\text{m}^3$, and recommended not adopting any of the related recommendations (as no party met their burden of proof to update the values).³⁸

C. Value of Statistical Life and Concentration Response Function

1. Value of Statistical Life

From the ALJ Report on the value of statistical life (VSL): "The Agencies converted negative impacts on human health to monetary terms using results from the non-market valuation literature in economics. They explained that the VSL "is a rate, measured in units of money per unit probability." It measures the maximum rate a person would pay to slightly reduce his chance of dying (mortality risk), generally within the current year. It is neither an estimate of what a person would pay to avoid certain death, nor an estimate of how much a person would demand to accept certain death. The Agencies cited examples of people paying a certain sum to avoid an increased risk of death, such as purchasing bicycle helmets, smoke detectors or fire extinguishers. ..." ALJ Conclusion 38.

The ALJ recommended a VSL of \$7.70 million.³⁹

Because there is no generally-accepted "correct" VSL value, the Agencies used two VSLs in their AP2 analysis "in an attempt to generate a range of damage estimates."⁴⁰ The Agencies recommended values of \$3.7 to 9.5 million using the EPA's VSL (2011) of \$9.5 million as their high end and analysis of other studies for their low end estimate. CEO's used the EPA value as their (non-range based) recommendation, but updated (slightly differently than the agencies) to 2015 dollars, to be \$9.8 million.

As with the concentration response function, Xcel here also reviewed updated reports on the VSL, including an additional three studies of varying types, and based on that data⁴¹ it

³⁷ See MLIG Initial Exceptions at 67.

³⁸ MLIG Reply Exceptions at 25.

³⁹ ALJ Recommendation 2.

⁴⁰ ALJ Report Finding 40.

⁴¹ ALJ Report Findings 140 – 146.

recommended a VSL distribution and low and high values based on the 25th and 75th percentiles of \$4.1 to 7.9 million. However, upon exceptions, Xcel noted a range would be better to account for uncertainty and found they could accept the ALJ's VSL value of \$7.7 million as the high-end of a range, as that value is within their recommendation. However Xcel recommended a low end value should be adopted (either the Agencies of \$3.7 or Xcel's of \$4.1 million).

2. Concentration Response Function

Parties generally relied on several of the same 'landmark' studies in relation to the PM_{2.5} impact on mortality, largely the Lepeule 2012 update of the Harvard Six Cities study (Lepeule or Six Cities) and Krewski's 2009 update of the American Cancer Society study (Krewski or ACS study). Specifically, both studies evaluated incremental increases in PM_{2.5} and that increase's expected relation to mortality rates.

The ALJ recommended a concentration response of 6.8 percent, or if the Commission believes a range to reflect uncertainty is more reasonable, recommended a range of 6 percent to 7.3 percent.⁴²

The Agencies argued that application of the low or high end values of the studies would have a significant effect on total damages as air pollution damages relate to mortality effects, which are a significant portion of total damages. The Agencies proposed values of 6-14 percent (in 10 µg/m³) based on the low and high end of the study estimates. The CEOs relied on the same studies, but found the conclusions of the studies to be a range of 7.8 to 14 percent.

Xcel used the same two studies, and the addition of a third, more recent study, the Hoek study meta-analysis. Xcel's witness assigned weights to each of the three studies, then conducted a Monte Carlo analysis to estimate mortality risks from exposure to PM_{2.5} and ultimately recommended a range of 5.3-7.3 percent. The Agencies and CEOs opposed this methodology, believing Xcel's weighting system was arbitrary, among other claims. Xcel also included impacts from morbidity from PM_{2.5} exposure as well as O₃ and in their proposed values, impacts not included by the other parties.

3. ALJ Conclusions, Recommendations, and Exceptions on VSL and CR

a. ALJ Recommendations on VSL

ALJ Recommendation 2: The Administrative Law Judge respectfully recommends, consistent with the parties' various recommendations, that the Commission adopt a VSL of \$7.7 million.

Parties' Final Positions

⁴² ALJ Recommendation 3.

CEOs recommend the Commission amend this to use the EPA's VSL, adjusted to current value based on changes in income and inflation consistent with their recommendation, of \$9.8 million.

The Agencies recommended a range of \$3.7-9.5 million and through exceptions, noted they continue to recommend such.⁴³

Xcel recommend use of the \$7.7 number as the high end of a range, and that the Commission use either the Agencies' or Xcel's low end estimate of \$3.7 or \$4.1 million.

b. ALJ Recommendations on the Concentration Response Function

ALJ Recommendation 3: The Administrative Law Judge respectfully recommends, consistent with the parties' various recommendations, that the Commission adopt a concentration-response function of 6.8 percent, or if the Commission prefers to adopt a concentration-response range to reflect uncertainty, a range of 6 percent to 7.3 percent.

Parties' Final Positions

CEOs recommended the Commission amend this to use the concentration response function values given by Krewski and Lepeule, 7.8 and 14 percent.

The Agencies recommended a range of 6-14 percent, and noted that they do not strongly object to the ALJs recommendation of 6.8-7.3 percent, however, they do agree with the CEOs that there appears to be a discrepancy between her finding 50 and her conclusion (of 6.0-7.3 percent). While the Agencies do not agree with the ALJs decision to 'eschew' the higher value of 14 percent from the range, they do not find her recommendation unreasonable.⁴⁴

Xcel recommended use of the ALJ's range and not a specific concentration response function of 6.8 percent.

c. Conclusions on VSL and CR

- ALJ Conclusion 48 - The Administrative Law Judge concludes that although Xcel, the CEOs and the Agencies' criticized one another's' approaches to establishing recommended VSL and concentration-response functions, the parties ranges of acceptable values overlapped. The recommended ranges for dose concentration-response percentages and VSL amounts are as follows:

⁴³ Agencies Reply Exceptions at 3.

⁴⁴ Agencies Reply Exceptions at 1.

	Xcel ⁴⁵	CEOs ⁴⁶	Agencies ⁴⁷
VSL (in \$millions)	\$4.1-\$7.9 \$5.9 mean	\$9.8 Alternative \$7.7 (2015 \$)	\$3.7 - \$9.5 (2011\$)
Dose-Concentration Response	5.3%-7.3% 6.8% mean	7.8% (6% not unreasonable)	6%-14% (7.8% not fundamentally disagreeable)

- ALJ Conclusion 49 - The Administrative Law Judge concludes that \$7.70 million is a reasonable VSL value which is within the recommended range for Xcel, the Agencies and the CEOs.⁴⁸
 - The CEOs argued that the ALJ did not provide sufficient basis to adopt her VSL, that the characterization that CEOs supported a value of \$7.7 million is inaccurate, and the Commissions should instead adopt the EPA's value^{49, 50} The CEOs argued that the mention of the \$7.7 million value in testimony was only provided in for the 'sake of discussion' and that it was never a recommended value by the CEOs.⁵¹
 - Xcel recommends adoption of a range of \$4.1 to \$7.7 million to account for uncertainty (or \$3.7 million, which is the Agencies low end value).
- ALJ Conclusion 50 - The Administrative Law Judge concludes that 6.8% - 7.3% is both reasonable, and an acceptable dose-concentration response function range for Xcel, the Agencies and the CEOs.⁵²
 - CEO's argued that the ALJ misrepresented the CEOs position on the concentration response function, in that they did not agree that a value of 6 percent was a

⁴⁵ Ex. 604 at 24; WHD-1, Schedule 2 at 38 (Desvousges Direct).

⁴⁶ Ex. 115 at 22, 25 (Marshall Direct); Ex. 117 at 7 (Jacobs Rebuttal); Ex. 118 at 8 (Polasky Rebuttal).

⁴⁷ Ex. 808 at 41-42 (Muller Direct); Ex. 809, NZM-2 at 11-12 (Muller Direct Attachments); Ex. 811 at 30 (Muller Surrebuttal).

⁴⁸ Ex. 115 at 25 (Marshall Direct); Ex. 117 at 7 (Jacobs Rebuttal); Ex. 604 at 24 (Desvousges Direct); Ex. 808 at 41-42 (Muller Direct). The Administrative Law Judge notes that \$7.70 would be \$7.31 in 2011 dollars, still within the Agencies' range. Xcel did not specify the year for which its recommended range was expressed, but it referred to its study as a "2015 Study." Ex. 604 at 24 (Desvousges Direct). For purposes of this conclusion, the Administrative Law Judge presumes that \$7.70 falls within Xcel's recommended range as well.

⁴⁹ Staff notes that adjustments to the EPAs 2011 VSL to 2015 dollars has been calculated differently by different parties, resulting in different 2015 figures. The CEOs recommend in exceptions that the Commission determine the proper inflation adjusted number upon approval of the EPA's VSL.

⁵⁰ CEOs Initial Exceptions at 14.

⁵¹ CEOs Initial Exceptions at 16.

⁵² Ex. 117 at 7 (Jacobs Rebuttal); Ex. 118 at 8 (Polasky Rebuttal); Ex. 604, WHD-1, Schedule 2 at 38 (Desvousges Direct); Ex. 809, NZM-2 at 11-12 (Muller Direct Attachments); Ex. 811 at 30 (Muller Surrebuttal).

reasonable concentration response function.⁵³ While CEOs acknowledge that its witness described the differences in interpretation of the Krewski Study (between 6.8 or 7 percent) as a ‘matter of professional judgement’ the CEOs did not find 6.8 acceptable, nor did they ever rescind their recommended high end value of 14 percent.

- The CEOs also note there appears to be an inconsistency between the range in the Conclusion 50 (that 6.8-7.3 percent is an acceptable range to parties) and the ALJ Recommendation 3 which provides a range of 6.0-7.3 percent. The Agencies and Xcel agree.
- The Agencies do not find the ALJ recommendation unreasonable.
- Xcel recommends adoption of the ALJ’s range, but with the modification to read “6.0-7.8%”.

4. Staff Discussion

The Commission could determine 1) that the ALJ’s recommended VSL and CR values are reasonable, and adopt them, 2) find that other VSL or CR values are more reasonable, or, if the Commission finds Xcel’s proposed externality *values* are the best value put forth on the record (the ultimate \$/ton figure), it could adopt Xcel’s externality proposal; inherent in those final values would be Xcel’s recommended VSL and CR values. However, if the Commission wishes to further review the proposals, and potentially modify inputs, staff discusses each in turn, below.

Value of Statistical Life

The ALJ recommended \$7.7 million as the VSL. Both the Agencies and CEOs continued to recommend their preferred number, the EPA’s VSL, updated to current dollars. Xcel recommends a range, using the high end of \$7.7 million and the low end of either their proposal or the Agencies. The VSL is noted by parties as having a large effect on the final externalities values. However, staff does not believe it would be unreasonable to use the low end of the Agencies’ values (of \$3.7 million) and the high end of the EPA VSL, updated to reflect 2017 dollars, however, additionally, staff advocates for use of conservative values, as noted by the previous ALJ report (and adopted by the Commission) finding on the merits of being conservative when setting externality values (discussed above).

Concentration Response

In exceptions, two of the three parties who provided CR values find the ALJs recommendation of 6.0-7.8% reasonable. The CEOs, do not, and do not agree that adopting a range based on consensus is a reasonable approach; they argue they did not rescind their recommendation of

⁵³ CEOs Exceptions at 9.

their high value of 14%. However, staff believes adopting a range to reflect uncertainty is a reasonable approach strongly supported by the previous record and by the externalities statute. While parties may disagree on the ultimate parameters of that range, the Commission has before it, several experts in the field providing their expert opinions on largely the same studies. Staff believes the Commission could adopt the ALJ recommended range (correcting Finding 50 for the discrepancy) and would be accounting for a range of values in which all parties found some basis of reasonableness. The Commission could also raise the high end of the range to 14%, but again, staff continues to agree with the previous Commission decision in which it found merit in being conservative.

D. Spatial Sensitivity – Emission Sources and Locations

1. Background

In the 1997 Externalities Order, the Commission found that a three tiered emission source location metric was the most appropriate (urban, metro-fringe, rural) to determine the externality cost of any future facility. For any emission source located outside of Minnesota, but within 200-miles, the rural values were to be applied.⁵⁴

It is not possible for the Commission to establish environmental values that apply perfectly to every potential resource option. As noted previously, such a goal is beyond what is required in the quantification stage. The Commission does find it possible and appropriate, however, to adopt some refinements in the quantification process at this time to reflect the following factor: proximity to population centers.

- The amount of damage imposed by many pollutants depends largely on site-specific factors, including the number of people likely impacted by the emission.
- In addition, the level of geographic sensitivity is not uniform for each pollutant but varies from pollutant to pollutant.

Recognizing that environmental impacts will vary depending on the circumstances of the particular resource option in question, the Commission has adopted **ranges** of values for the various pollutants and, in addition, has found it appropriate to adopt ranges that differ depending on the location of the proposed generation site: urban, metropolitan fringe, and rural. The Commission's adopted values also reflect that the level of geographic sensitivity of each emission is not uniform but varies from emission to emission. No further pinpointing of emission levels or costs per unit of emissions is necessary or possible at this time. In future proceedings, the parties addressing particular resource options will establish a record for the Commission's evaluation.

⁵⁴ 1997 Order Establishing Externality Values, Docket E999/CI-93-583, at page 15.

There are two main questions regarding spatial sensitivity: what sources (locations of hypothetical future plants) are included in the IAMs as having an impact to Minnesota, and once calculated, how those values should be applied to resources outside the state.

In the 1997 decision, the modeling calculated was based roughly on Minnesota-only damage costs; once that number was calculated, it was acknowledged based on the record that emissions from out-of-state resources could cause damages in Minnesota (as pollutants aren't bound by state lines), and therefore, the rural values were ultimately to be applied to resources located outside of Minnesota (but within the 200-mile range, and within the US). Ultimately that approach was a simple, and conservative method of applying the values. However, due to that previous decision, and acknowledgement that out-of-state resources contribute to in-state damages at a range of up to 200-miles, parties took varying approaches to use of emission sources in this current docket, some more complex than others, and as the ALJ described it, potentially 'cumbersome and confusing'.⁵⁵

In this current proceeding, and based off the earlier decisions, Xcel took a simplistic approach (but with a more complicated model) and modeled three hypothetical plants to determine their contribution to emissions; one plant for urban, metro-fringe, and rural areas; Xcel did not model any emission sources located out of the state, which was consistent with the previous proceeding. The ALJ found this put Xcel at a disadvantage in evaluating NO_x impacts.⁵⁶

The Agencies and CEOs attempted to model (with simple models) both in-state and out-state emission sources to best capture the effects pollutants have based on differing locations (as population is a large factor in the resulting damage) and modeled at the county level. The Agencies recommended the continued use of 200 miles as the limit of sources because emissions from these sources could have an impact on Minnesota's air quality and because these out-of-state sources may generate electricity to meet demand in Minnesota.

Therefore, the Agencies modeled hypothetical plants in each of Minnesota's 87 counties, 6 locations within Minnesota with existing facilities, and 400 locations outside of Minnesota, for a total of over 3,000 modeling runs. The Agencies assumed that each hypothetical plant was located at the geometric center of the county. The Agencies provided various ways in which the Commission could use their externality values, as averages, as county-by-county values, etc. (see ALJ Findings 72-78).

The CEOs took a similar approach by modeling a hypothetical plant in all Minnesota counties as well as counties in the US within 200 miles surrounding Minnesota, including existing out-of-state plant locations, for a total of nearly 500 counties in 9 states. The CEOs assumed that emissions averaged across the geographic area of the county. The CEOs proposed values for each county and argued that values should not be combined or averaged as that would negate the value of the (geographically) small-scale approach, the ALJ agreed.⁵⁷

⁵⁵ ALJ Report, Conclusion 30, at page 98.

⁵⁶ ALJ Report, Finding 182.

⁵⁷ ALJ Report, Recommendation 4b.

2. ALJ Conclusions, Recommendations and Exceptions on Spatial Sensitivity (Emissions)

The ALJ recommended at ALJ Recommendation 4:

4. The Administrative Law Judge respectfully recommends that the Commission choose one of the following options to determine the costs of CP Externalities:

- a. Adopt a model configuration that provides a five- or six-tiered version of Xcel's three-tiered proposed sources and source locations. The Administrative Law Judge recommends that the additional tiers incorporate factors such as nearby topography, vegetation, buildings, etc. consistent with the Agencies' recommendations. The tiers could accomplish this by including variations on the rural category to account for rural settings that are isolated versus rural settings that are less so, and possibly a "small town" category. This would enable the Commission to gain additional information beyond the three categories Xcel proposed. If the Commission chooses this option, the Administrative Law Judge respectfully recommends that the Commission choose the CAMx model, if the Commission finds that the CAMx model would be practicable to use with this somewhat expanded scope. The Administrative Law Judge recommends the CAMx model because it is more reliable than AP2.
- b. Adopt a model configuration that includes all 87 counties in Minnesota, but only out-of-state sources that reflect active EGUs in the out-of-state locations. The Administrative Law Judge recommends that county-specific information not be combined or averaged, but used as the CEOs recommended it be used. In addition, the Administrative Law Judge recommends that the Commission exclude out-of-state sources located in eastern Wisconsin, Michigan and Illinois. If the Commission chooses this option, or some variation of it that is similar in scope and size, the Administrative Law Judge recommends that the Commission choose the AP2 model, which is generally recognized as a reliable model and would be capable of modeling the much larger number of modeling runs needed with this configuration.

Xcel provided exception to this recommendation specifically to authorize the CAMx model, as-is, with the three tier model, and to strike the discussion regarding the use of AP2.⁵⁸ Xcel argued its modeling was sufficient and that there are inherent problems with the AP2 model, not only the modeling as performed by the Agencies.⁵⁹

⁵⁸ See Xcel Initial Exceptions at Attachment A at 1.

⁵⁹ Xcel Initial Exceptions at 18-42.

The ALJ concluded regarding spatial sensitivity-emission source and source locations, that:

- ALJ Conclusion 29 - The Administrative Law Judge concludes that the Agencies demonstrated by a preponderance of the evidence that Xcel's choice to model just three emission source locations within Minnesota put Xcel at a disadvantage in analyzing the spatial impact patterns of NO_x.⁶⁰
- ALJ Conclusion 30 - The Administrative Law Judge concludes that the Agencies' statement that it is necessary to model sources outside the state if the Commission wishes to know what the impacts are from emissions produced outside the state does not require the Commission to adopt externalities values in this proceeding which include almost 400 sources and source locations outside Minnesota's borders, a number which makes including outside sources and source locations cumbersome and potentially confusing.

The Agencies clarified that if the Commission finds the level of information provided by the Agencies is not useful, it can disregard it. The Agencies modeled sources within Minnesota and within 200 miles as a result of the 1997 decision, in that it found that those resources are likely to provide power to Minnesota and are likely to impact Minnesota with their emissions and that information could be used in several ways by the Commission (explained in Muller's Surrebuttal at 27).

- ALJ Conclusion 31 - The Administrative Law Judge concludes that sources and source locations that are situated considerably southeast of Minnesota, such as in the vicinity of Milwaukee and Chicago, appear less likely to capture many emissions that will impact Minnesota locations than sources and source locations that are to Minnesota's west, south, southwest and northwest.⁶¹

CEOs recommend rejection as not supported by evidence. The CEOs argue that this finding (along with 31-33, 34 and 45) regarding emission source locations are not consistent with [the CEO's interpretation of] the statute, in that it doesn't matter where the emission source is located; so long as it is reasonably likely to generate power that is to be used in Minnesota and that actual damages need to be quantified, regardless of whether of whether emissions are more or less likely to impact Minnesota. CEOs argue that the citation to Finding 43 does not align or support this conclusion.⁶² The CEOs also object to ALJ Recommendation 4b, which is consistent with this finding, for the same reasons outlined.

The Agencies recommended the Commission delete this finding as it is erroneous and misleading since EPA modeling has shown that there are impacts to Minnesota from resources to the Southeast; impacts can vary based on meteorology during a particular year.

⁶⁰ See Findings 180-182 of this Report.

⁶¹ See Finding 43 of this Report.

⁶² CEOs Initial Exceptions at 21

- ALJ Conclusion 32 - The Administrative Law Judge concludes that the Commission's understanding of impacts from emissions produced outside the state does not require modeling of source locations outside of Minnesota where there are currently no active plants. Should such a plant be built in the future, the Administrative Law Judge concludes that the Commission can substitute the emissions costs from an existing (or hypothetical) source to estimate the effect of a new plant.

CEOs recommend rejection as this, and 33, answer questions not asked of the ALJ.⁶³ Again, CEOs argue that what was required in the proceeding is to provide useful cost values based on what is practicable to model today, which CEOs argue is Minnesota and a 200-mile range surrounding it.

Agencies argue that this conclusion is modified as resources selected in an IRP could be located outside of Minnesota, and therefore, this data would be useful.

~~The Administrative Law Judge concludes that the Commission's understanding of impacts from emissions produced outside the state does not require modeling of source locations outside of Minnesota where there are currently no active plants. Should such a plant be built in the future, the Administrative Law Judge concludes that the Commission can substitute the emissions costs from an existing (or hypothetical) source to estimate the effect of a new plant.~~

- ALJ Conclusion 33 - The Administrative Law Judge concludes that, in suggesting three approaches to using the damage costs for the out-of-state sources, the Agencies have not demonstrated how they will prevent the CP externalities values for these locations from including damages to out-of-state locations caused by out-of-state sources, should the Commission choose to include out-of-state impacts as well as out-of-state sources. For example, the Agencies have not demonstrated how damages in a Chicago receptor location attributed to a source location in Wisconsin will not be included in Minnesota CP externalities numbers.

CEOs request rejection (see reasoning under 32 above).

The Agencies also recommend rejection of this conclusion as they argue they did provide methods to exclude out of state emissions from being included in Minnesota damages. The Agencies propose addition of the word 'not' ('should the Commission not choose') to the second sentence to better capture their position.⁶⁴

⁶³ CEOs Initial Exceptions at 22.

⁶⁴ Agencies Initial Exceptions at 7.

Staff believes this disagreement comes from where parties and the ALJ believe the MN-scope should exist, when reading this from the position that the ALJ may be coming from, specifically due to her use of the term ‘Minnesota CP externalities number’ she likely believes there should be some connection to Minnesota beyond what the Agencies and the CEOs find the necessary Minnesota-connection to be (potential for MN impact and MN used power). Staff assumes the ALJ is attempting to find the Minnesota portion of (or Minnesota connection to) the calculated externalities value in scenarios in which an out-of-state resource has damages calculated far beyond Minnesota (and therefore that impact isn’t entirely to Minnesota and all the electrons generated are not used in Minnesota). CEOs and the Agencies take a different approach, and therefore disagree with her conclusion. Depending on how the Commission views the framing of this case will determine the position the Commission should take on this conclusion.⁶⁵ The Agencies further this discussion in their exceptions – and note that while limiting the damages to Minnesota was done in the previous case, the Agencies advocate for a broader scope here.

- ALJ Conclusion 34 - The Administrative Law Judge concludes that the Commission’s decision in the First Externalities case to establish the three-tiered urban, metropolitan fringe and rural structure for all locations within Minnesota as well as to locations within 200 miles of the Minnesota border was made as the most reasonable, practicable decision at the time. This proceeding is the first opportunity the Commission has had to reconsider externality values or the structure of sources and source locations since it made that decision. As the parties have demonstrated in this proceeding, the science and the modeling capabilities have matured significantly since the First Externalities proceeding. Therefore, the Administrative Law Judge concludes that it would be reasonable for the Commission to choose some other means of structuring source locations, should it decide that another structure is practicable and necessary to provide additional useful information for resource planning, certificate of need, or other proceedings before the Commission.
- ALJ Conclusion 35 - The Administrative Law Judge concludes that the Agencies and the CEOs did not demonstrate, by a preponderance of the evidence, that their county-by-county source approach within Minnesota is a reasonable approach. It is not reasonable because nothing in the record indicates the Commission requires or has expressed a need for this level of detail in resource planning or certificate of need or related proceedings.

The agencies provide that the county-by-county approach is how the AP2 model works, and the Commission can use the data in any way deemed reasonable – hence the significant strength of the AP2 model. The Agencies noted that the

⁶⁵ The Agencies note that if the Commission wants to disaggregate MN damages from an out of state resources, AP2 can be set with those parameters. (Agencies Initial Exceptions, at 7).

Commission did not specify any level of detail, and therefore, doesn't make their proposal 'unreasonable'. The Agencies recommend rejection of this conclusion.⁶⁶

- ALJ Conclusion 36 - The Administrative Law Judge concludes that the Agencies' claim that the EPA's CAMx modeling run of the effect of Minnesota NO_x emissions on ambient concentrations of PM_{2.5} across a number of states showed, for the time period included in the CAMx simulation, that approximately "two-thirds of the impact on concentrations of PM_{2.5} from NO_x emissions produced by power plants in Minnesota occurs outside of the state"⁶⁷ is not supported by a preponderance of the evidence. While the mathematics behind the Agencies' statement appears to be straightforward on its face, the calculation was based on ambient monitoring receptor locations in the states involved.⁶⁸ There is no dispute that there is no relationship between the size of the state and the number of receptors. States choose to site receptors for a variety of reasons.⁶⁹ The Agencies' witness, Dr. Muller, acknowledged "If I were to design an experiment to glean this information, I would not do it this way. I was working with the best information that I had available, which is the network of monitoring sites" ⁷⁰ Dr. Muller continued "that this is a suboptimal way to show that" ⁷¹ The Agencies relied on data that is unreliable for the present purpose.

The Agencies acknowledged the crudeness of the data, and that Dr. Muller did as well, however the intent of providing the information was to qualitatively (not quantitatively corroborate the correctness of the statement that 'a significant portion of damages are out-of-state'. The Agencies argued that the ALJ agrees with this position in Conclusion 37, and therefore they recommend changing 'unreliable' in the last sentence to 'insufficient'.⁷²

Staff finds this modification reasonable and consistent with the record.

- ALJ Conclusion 37 - The Administrative Law Judge concludes that the preponderance of the evidence demonstrates that primary PM_{2.5} causes damages which are mostly local and regional. The Administrative Law Judge concludes that the preponderance of the evidence demonstrates that SO₂, and NO_x can travel significant distances, forming secondary PM_{2.5} hundreds of miles from the source from which they were emitted.⁷³ The Administrative Law Judge concludes that the preponderance of the evidence failed to demonstrate the percentage of SO₂, and NO_x emitted in Minnesota that cause impacts and damages outside the state of Minnesota because the Agencies relied on skewed data

⁶⁶ Agencies Initial Exceptions, at 9.

⁶⁷ Ex. 811 at 24 (Muller Surrebuttal).

⁶⁸ Tr. Vol. 8 at 104-110 (Muller).

⁶⁹ *Id.*

⁷⁰ *Id.* at 110.

⁷¹ Tr. Vol. 8 at 110 (Muller).

⁷² Agencies Initial Exceptions at 9.

⁷³ Ex. 620 (EPA CSAPR spreadsheet); Ex. 621 (EPA CSAPR map).

to demonstrate that two-thirds of NO_x emissions from Minnesota cause damages outside of Minnesota.⁷⁴

The Agencies argued that this finding lacks clarity and has mixed messages as suggested the following edit:⁷⁵

~~...The Administrative Law Judge concludes that the preponderance of the evidence failed to demonstrate the precise percentage of SO₂, and NO_x emitted in Minnesota that cause impacts and damages outside the state of Minnesota because the Agencies relied on skewed data to demonstrate that two-thirds of NO_x emissions from Minnesota cause damages outside of Minnesota.~~⁷⁶

- ALJ Conclusion 38 - The Administrative Law Judge respectfully recognizes that the Commission may decide that it would be useful to have county-level CP externalities costs available to it. This is a policy decision most appropriately made by the Commission. The Administrative Law Judge concludes that the Agencies and the CEOs demonstrated by a preponderance of the evidence that the computational intensity of CAMx would make it impracticable to use if the Commission were to determine that it prefers to adopt an approach involving many more sources and source locations than the approach taken by Xcel in this proceeding. The number of data runs required to accomplish the Agencies' and CEOs' approach renders the possibility of using a photochemical model impracticable. The Administrative Law Judge concludes that, should the Commission choose the county-by-county approach, the AP2 model would be the best reduced form model for such an approach.
- ALJ Conclusion 39 - The Administrative Law Judge concludes that, if the Commission determines that an approach to sources and source locations similar to that proposed by Xcel will meet its needs, then CAMx is the most reliable and accurate model of the three models presented in this proceeding. Whether CAMx is practicable in that situation is a question that the Administrative Law Judge respectfully concludes is best determined by the Commission, based on the Commission's evaluation of the time and expense involved in re-running the CAMx model.

3. Staff Discussion

Staff agrees with the ALJ that the Commission could adopt either approach to modeling, a more generic source location approach, as Xcel has provided, or a county-by-county level model. While these questions go back to the earlier considerations, about whether the Commission wishes to have parties redo their modeling, the Commission could pursue multiple avenues – but the level of process to follow may vary.

⁷⁴ See Finding 38 of this Report.

⁷⁵ Agencies Initial Exceptions at 9.

⁷⁶ See Finding 38 of this Report.

However, the Commission should consider the level to which it need specific values and to what extent those values provide actual precision. While the county by county approach appears to provide accurate data, it is providing that information using reduced form modeling, and several inputs that reduce the level of accuracy it appears to provide. The use of an area source input by the CEOs, and the related assumptions, call the specificity of their county values into question (among many other concerns expressed by other parties and the ALJ). Additionally, the Agencies used a very simplified model (in which the Commission required of them), that Xcel reasonably called into question regarding its accuracy and performance.

The Integrated Resource Planning (IRP) rarely utilizes county-specific data and it is largely not known with any level of assurance of where a resource will be located; we are typically looking at generic resources for long term planning processes. While more recently, it is more likely to be a known location in the certificate of need proceeding; it is also likely that that type of facility has already been generically vetted through the IRP process. Additionally, staff agrees with the arguments of Xcel regarding the balancing of factors required by the Commission at the stage at which the externality values are applied:

Finally, in the resource acquisition process, the externality values are used in the final stage of the process when specific proposals are weighed against each other by the Commission. However, the externality values are by no means the only consideration driving the process. Specific proposals to build new fossil-fueled resources and the location of those resources are also driven by transmission capacity, proximity to existing gas pipelines, distance from population and industrial centers, access to water, land ownership, soil conditions, wild life, and costs to build and operate a facility in its specific location. In fact, we doubt there are very many counties in Minnesota that would be seriously considered as a suitable, potential location for a new thermal power plant by any Minnesota utility. Therefore, it is not necessary or practical to develop county-specific values for the resource acquisition process either.⁷⁷

Staff believes there is greater benefit in having more accurate generic values to apply at the IRP stage, when the process is more nimble and consideration of resource additions is still in development, versus having less precise (but more locational specific) values to apply at the late-stage resource acquisition process when more facility specific factors are likely weigh more heavily on the Commission decision (like transmission access, available location, etc.).

Further, the CEOs argue that the Commission should also require the modeling of differing stack heights, as they proposed – effectively modifying ALJ Recommendation 4b. Staff believes this compounds the specificity question further.

⁷⁷ Xcel Initial Brief at 62.

E. Geographic Scope of Damages

1. Background

In the original externalities case, the Commission calculated damage values occurring within Minnesota. Very generally and for example, for crop loss, only the monetary impact of the pollutant's damages to Minnesota's crops were included in the externality value and monetary damage to Nebraska's crops were not included in the final values; they were not calculated. It was acknowledged in the previous case that damages from criteria pollutants occur mostly locally and regionally, and therefore, calculating damages within Minnesota (and not nationwide) was reasonable.

With the exception of the values adopted for CO₂, which causes damages globally rather than regionally or locally, the Commission has quantified the costs of environmental damage occurring in Minnesota. ... With respect to CO₂, this means assessing damage globally; for all other pollutants for which values are established by this Order, it means quantifying the damage they cause in Minnesota.⁷⁸

Additionally, from the previous order:

The general proposition that emissions generated in another state can do environmental damage in Minnesota appears indisputable. But since the levels and amounts of damages are a function of distance, at some distance from the Minnesota border, generating plant emissions lost their ability to damage the Minnesota environment.

With respect to all the pollutants quantified in this Order except CO₂, for which global damages are addressed below, the Commission finds that the record supports finding in-state damages from a generating plant located up to 200 miles from the state border, but that it is not practicable (on the current record) to establish values for damages caused by emissions originating within the 200 mile band, as recommended by the Department and the ALJ. Environmental cost values from generation sites located beyond the 200 miles band are deemed to be zero.

The Commission notes that the statute on its face does not differentiate between in-state generation and out-state generation ... The Commission, therefore, has executed its mandate under the statute to quantify all generation-related damages occurring in Minnesota, regardless of the location of the generating site in question, to the extent it is feasible to do so.⁷⁹

Parties argue a combination of policy and science related positions to support their geographic related arguments and are discussed briefing above in *Geographic Scope – Legal or Policy Question*.

⁷⁸ 1997 Order – pg. 15.

⁷⁹ 1997 Order – pg. 15.

As noted above, the Commission could determine that these issues are a matter of policy and make early determinations that the emission sources or the geographic scope of damages should be limited, based on law, or the previous Commission decisions, or the Commission could evaluate these issues based on the record evidence before it in making these determinations (or ultimately, a combination thereof).

Staff views general questions in this record related to geographic damages as:

- Whether the *statute* requires us to calculate all damages caused by the criteria pollutants (either in-state or out) regardless of the damage location (or if it does the opposite) (i.e. including cost from Florida crop damage caused by MN-related emissions);
- Whether the Commission already decided the scope in the previous proceeding and sets a reasonable precedent here;
- Whether it is possible to calculate damage values outside of Minnesota with sufficient accuracy; and,
- Whether it has been proven on this record that significant impacts occur/can be calculated outside of Minnesota.

2. ALJ Conclusions, Recommendations and Exceptions

Very generally, the ALJ recommended that the geographic scope of damages is a policy decision to be made by the Commission. She acknowledged that emissions travel beyond Minnesota boundaries, but that the CEOs and the Agencies did not demonstrate that their use of their models was sufficient to estimate those damages. She also acknowledged that the Federal Cross State Air Pollution Rule did not mitigate against all impacts of pollutants.

ALJ Recommendation 5. As explained in Conclusion 46, the Administrative Law Judge concludes that the question of geographic scope of damages is a policy matter to be decided by the Commission. If the Commission chooses to include the contiguous U.S. or some substantial area outside of Minnesota in the CP externalities costs, the Administrative Law Judge respectfully recommends the CAMx model as the most reliable model to calculate those externalities costs.

The CEOs took exception to her recommendation 5, requesting an amendment to require a US continental scope 'consistent with the legal requirement to model actual damages to society and the practicability of modeling nationally using current science'.

The ALJ specifically concluded the following relating to geographic damages:

- ALJ Conclusion 40 - The Administrative Law Judge concludes that the CEOs and the Agencies demonstrated by a preponderance of the evidence that emissions from Minnesota EGUs travel beyond Minnesota boundaries.

- ALJ Conclusion 41 - The Administrative Law Judge concludes that the CEOs did not meet their burden of demonstrating that InMAP is sufficiently accurate to rely on its estimates of CP externality values, including damages occurring within the entire contiguous U.S. The Administrative Law Judge's conclusion is based on the issues discussed at Conclusions 8 through 12 above, and the additional concern that the InMAP model "skews changes in ambient concentrations to the east based upon annual meteorological data and has results significantly higher than those obtained by [Xcel's and the Agencies'] modeling . . ." ⁸⁰
- ALJ Conclusion 42 - The Administrative Law Judge concludes that the CEOs and the Agencies demonstrated, by a preponderance of the evidence, why they chose the studies they relied upon for their damage cost analyses.
- ALJ Conclusion 43 - The Administrative Law Judge concludes that neither the CEOs nor the Agencies have proved by a preponderance of the evidence that their respective InMAP or AP2 models can reliably predict CP externality values across the contiguous U.S. As stated in Conclusions 8 and 9, the CEOs failed to demonstrate that, at this time, InMAP is generally recognized as reliable. In addition to the general concerns about InMAP's reliability, the Administrative Law Judge concludes that the CEOs failed to rebut Xcel's statements that InMAP "skews changes in ambient concentrations to the east based upon annual meteorological data and has results significantly higher than those obtained by [Xcel's and the Agencies'] modeling . . ." ⁸¹
- ALJ Conclusion 44 - The Administrative Law Judge concludes that the Agencies failed to overcome the questions raised by Xcel concerning application of the AP2 model to predict CP impacts at distances significantly beyond the 50 kilometers recommended by the EPA. The Agencies' failure is particularly troublesome in light of the twin concerns posed by the AP2 model's Gaussian plume and the nature of AP2's design that models individual pollutants separately, rather than leaving the stack simultaneously.

The Agencies argued that the EPA guidance, recommending the 50 km limitation was not intended for reduced form modeling and the Agencies are not aware of any EPA Guidance regarding the use of reduced form modeling for impacts greater than 50 kilometers from the emission source. The Agencies recommend the Commission not adopt this conclusion. Xcel asserted in reply comments that limitation applied, contrary to the Agencies' exception.

- ALJ Conclusion 45 - The Administrative Law Judge concludes that, regardless of the specific standards established by the federal Cross State Air Pollution Rule, the extent to which the CP damage costs for a receptor located in another state is fueled by sources

⁸⁰ Ex. 606 at 29 (Desvousges Rebuttal). In general, when the parties presented estimates for the externalities values adjusted to reflect consistent parameters and inputs for illustrative purposes to compare the models, the InMAP model produced significantly higher results for PM_{2.5} and NO_x and generally lower results for SO₂. See Findings 214, 222, 231 of this Report.

⁸¹ Ex. 606 at 29 (Desvousges Rebuttal).

outside of Minnesota is relevant to determining how much Minnesota sources are contributing to the other state's CP damage costs. For example, if a power plant in Wisconsin injects significant amounts of O₃ or NO_x into the Chicago area, and the Sherco plant contributes a small additional amount of NO_x to the Chicago area, the Sherco plant is not increasing the ambient concentration of PM_{2.5} in Chicago to the same extent it is likely increasing the ambient PM_{2.5} in Chicago. Put another way, but for the pollutants coming from Wisconsin, the NO_x traveling to the Chicago area from Sherco might result in much smaller increases in ambient PM_{2.5} concentration. Therefore, the Administrative Law Judge concludes that, if damages are based on ambient concentrations at receptor sites outside of Minnesota based on Minnesota sources and source locations, then any out-of-state sources of pollution must be excluded from the Minnesota damage costs.

CEOs recommend this finding be rejected as it is "based on a misunderstanding of atmospheric science and because it calls for the Commission to require impracticable modeling." CEOs argue that the ALJ is recommending, based largely on the last sentence, is that any modeling used for calculating Minnesota damage costs must not have out of state baseline emissions included in the ambient concentrations – which CEOs argue is unreasonable.

The Agencies also take a similar issue with this conclusion, and explain their understanding of the term 'Minnesota sources' to mean any source that has the potential to serve Minnesota load – and therefore, believes that any model was conducted to ensure that damages are properly reflected – contrary to what the ALJ believes may happen. At a minimum the Agencies recommend deletion of the 'for example' sentence

Staff does not interpret the ALJs Conclusion in the same manner as the CEOs, staff believes the last sentence is only seeking to clarify that there are no marginal emissions of a resource unintentionally included in Minnesota damages. While the example may not be entirely clear for parties, staff does not believe the last sentence of the finding to require impractical modeling. Staff believes that the models proposed by parties, which capture marginal increases in pollutants, fulfills the intent of this Conclusion.⁸² Staff is supportive of the Agencies recommendation to delete the 'for example' sentence, as the conclusion is then clearer.

- ALJ Conclusion 46 - The Administrative Law Judge concludes that the question of whether the geographic scope of damages should extend beyond Minnesota's borders (or, if Xcel's CAMx model is used, beyond Xcel's CAMx model's range) is a policy question which is properly answered by the Commission. The Administrative Law Judge concludes that

⁸² Staff believes the ALJ may have been attempting to discuss secondary PM_{2.5} formation and the effect differing ratios of pollutants (NO_x and O₃) have on rates of PM_{2.5} formation. Regardless of the example, the conclusory statement is reasonable and staff believes all parties modeled in such a way that out of state sources would be omitted from the 'marginal' Minnesota damage costs as each party modeled increases on ambient concentrations (as the ALJ noted).

Minn. Stat. § 216B.2422, subd. 3, is silent as to whether or not the legislature expected the Commission to include damages outside of Minnesota.

- ALJ Conclusion 47 - The Administrative Law Judge concludes that Xcel failed to demonstrate by a preponderance of the evidence that Minnesota's compliance with the standards established by CSAPR reduces cross-border CP damages to zero.

Xcel provided an exception that corrected this statement to read:

The Administrative Law Judge concludes that Xcel has failed to demonstrate by a preponderance of the evidence that Minnesota's is in compliance with the standards established by CSAPR, and this is one factor that speaks against adopting a nationwide scope for CP externality values. ~~reduces cross border CP damages to zero.~~

F. Models

1. Background

Parties used three main models in this proceeding and the ALJ addressed each in turn. As noted above, the choice of model largely is a reflection of the party's view on how the Commission should structure this matter (simple models for large volumes of sources and damages and complex models for limited sources and damages). Staff views general questions in this record related to models as:

- Whether the models selected by parties were inherently proven and peer reviewed as reasonable method to calculate values;
- Whether the models were reasonable to use to calculate externality values;
- Whether the models were utilized in a manner in which their results are ultimately useable;
- Whether the modeling results were proven to be reasonable and within appropriate performance evaluation methods.

2. InMAP Reduced Form Model – ALJ Conclusions

The ALJ concluded that regarding the use of the InMAP reduced form model:

- ALJ Conclusion 8 - The Administrative Law Judge concludes that the CEOs failed to demonstrate by a preponderance of the evidence that the InMAP model is reasonable, practicable and the best model to measure the CP externalities. The CEOs did not present evidence that InMAP has been accepted for publication following peer review.
- ALJ Conclusion 9 - The Administrative Law Judge concludes that significant departures from the more typical reduced form models embodied in InMAP are the kind of innovations that call for support through peer review and some demonstration that

InMAP has some history of having been relied upon in other settings for purposes analogous to the present proceeding.⁸³ Evidence of such support is not part of the record in this docket.

- ALJ Conclusion 10 - In addition to the general concern about InMAP as a model, the Administrative Law Judge concludes that several aspects of the CEOs' implementation of InMAP cast doubts on the CEOs' modeling results. The Administrative Law Judge concludes that the CEOs' choice to model counties as area sources rather than point sources may have led to inaccurate results.⁸⁴ While the CEOs provided the reason they chose to model counties as area sources, they did not respond to the underlying, substantive concern about the resulting inaccuracies that may have resulted from their choice. Thus, the CEOs did not meet their burden of demonstrating that modeling counties as area sources was reasonable.
- ALJ Conclusion 11 - The Administrative Law Judge concludes that the CEOs did not meet their burden of demonstrating that the performance evaluation comparing their results to 11 WRF-Chem control scenarios was valid because the CEOs failed to respond to Xcel's criticism that the WRF-Chem control scenarios were developed for measuring emissions from light-duty mobile vehicles, which are very different in nature from EGUs.⁸⁵
- ALJ Conclusion 12 - The Administrative Law Judge concludes that the complexities that InMAP claims make it more accurate and realistic, such as calculating movement within a grid of hundreds of thousands of cells, and modelling pollutants moving from gas to particulate matter then back to gas, make InMAP much less transparent than a typical reduced form model. The Administrative Law Judge concludes that the CEOs did not show, by a preponderance of the evidence, that InMAP is a reliable reduced form model.

3. AP2 Reduced Form Model – ALJ Conclusions

The ALJ concluded that regarding the AP2 Model and process proposed by the Agencies:

- ALJ Conclusion 13 - The Administrative Law Judge concludes that the Agencies demonstrated by a preponderance of the evidence that the AP2 model has been peer-reviewed and that AP2 and its predecessor model, APEEP, have substantial history of being utilized for purposes similar to AP2's use in this proceeding.

⁸³ Although InMAP is a reduced form IAM, it is complex in some ways. For example, the CEOs stated that InMAP can model transformations of the individual pollutants from gas-phase to particulate matter and back to gas-phase "using reaction properties that vary from location to location." Ex. 115 at 13 (Marshall Direct). The CEOs asserted that this modeling is more realistic than other reduced form models because other models "generally assume chemical reactions only occur in one direction at a rate that does not vary." *Id.* Similarly, the CEOs claim InMAP is designed to calculate both dry and wet deposition of pollutants in a spatially explicit manner, using a combination of theoretical information and data from WRF-Chem. *Id.*

⁸⁴ See Findings 191-192 of this Report.

⁸⁵ Ex. 606 at 9 (Desvousges Rebuttal).

- ALJ Conclusion 14 - The Administrative Law Judge concludes that the Agencies demonstrated by a preponderance of the evidence that it is reasonable to make annual estimates of O₃ and PM_{2.5} values, as opposed to daily estimates, for the purpose of developing inputs to calculate the mortality concentration-responses.
- ALJ Conclusion 15 - The Administrative Law Judge concludes that the Agencies failed to demonstrate by a preponderance of the evidence that modeling individual pollutants separately is an approach commonly used in this field. The Administrative Law Judge further concludes, based on Xcel's comparative damage results, that AP2's modeling of pollutants separately did not appear to result in overstatement of nitrate formed.⁸⁶

The Agencies disagreed that they failed to prove that individual modeling of pollutants in common in this field and cited to the fact that InMAP used this technique and cited to studies it had references in testimony.⁸⁷

- ALJ Conclusion 16 - The Administrative Law Judge concludes that the Agencies demonstrated, by a preponderance of the evidence, that population-weighted exposure is an important measure in the context of this proceeding because human health effects are a large portion of the damage cost.

Xcel proposed the addition of the sentence: Externalities values proposed by Xcel Energy included impacts of population weighted exposures[.] at the end of finding 16 to address Xcel's arguments that it *did* include population-weighted considerations in its values.⁸⁸ Xcel references to Desvougues Rebuttal Testimony that notes that the damages were relative to population concentrations, and therefore, 'population-weighted'.

- ALJ Conclusion 17 - The Administrative Law Judge concludes that the Agencies' proposal to update the CP externalities values by using a formula that projects changes in populations and mortality rates but holds emissions constant is not a reasonable approach. There is no reason to believe that emissions will remain constant. Given that emissions drive mortality rates in this context, and that mortality rates have the largest impact on damages, the Administrative Law Judge concludes that the Agencies' update proposal will not result in reliable updates for CP externalities.

The Agencies noted that they had no objections to this conclusion, but that it missed the point of their testimony, their intent was to provide projections of how damage values may change in the future and *not* to provide definitive values for future use. The Agencies suggested this modification:

The Administrative Law Judge concludes that, while not a reasonable approach to use to update the values, the Agencies' ~~proposal to update~~ projections of the CP

⁸⁶ Finding 214 of this Report.

⁸⁷ Agencies Initial and Reply Exceptions.

⁸⁸ Xcel Initial Exceptions at 5.

~~externalities values for future years by using a formula that projects changes in populations and mortality rates but holds emissions constant provides a useful indicator of how values may change over time. is not a reasonable approach. There is no reason to believe that emissions will remain constant. Given that emissions drive mortality rates in this context, and that mortality rates have the largest impact on damages, the Administrative Law Judge concludes that the Agencies' update proposal will not result in reliable updates for CP externalities.~~

In light of the Agencies' comments, staff believes either the modification to this conclusion, or omission of it is reasonable.

- ALJ Conclusion 18 - The Administrative Law Judge concludes that the Agencies failed to demonstrate by a preponderance of the evidence that the modeling of their hypothetical plants is reasonable. The Agencies assert the purpose of the hypothetical plants is to predict what the impacts would be if a plant were to be located in a county in a particular location. On one hand, the Agencies stated the hypothetical plants are intended to replace the values for the "largest emitters in the state"⁸⁹ but the Agencies' hypothetical replacement plants result in far higher damage costs than the Agencies' damage costs for the largest emitters.⁹⁰

The Agencies recommend that the Commission not adopt this finding as it appears to misunderstand the Agencies' purpose for providing evidence regarding the value ranges for hypothetical plants was different from the purpose of modeling actual plants.⁹¹

Staff has reviewed the arguments made by the Agencies and still doesn't entirely understand what the purpose of the modeling both of the actual and hypothetical plant location was intending to do; staff believes that replacing hypothetical county values with actual values would be reasonable, or that they could be used to validate modeling and show that the hypothetical plants are showing conservative values - but that doesn't appear to be what the Agencies ultimately did (nor did their modeling prove such). The Agencies may have a basis for the analysis they have conducted here, but it is not coming across in their explanation. Staff refers Commissioners to Muller Surrebuttal at page 21 and 22 (to which the ALJ cited). Staff believes that this ALJ finding is reasonable, as the Agencies had the burden to prove their modeling and assumptions were reasonable, and staff can still not interpret what the intent was here nor how it supported the Agencies' modeling inputs.

- ALJ Conclusion 19 - The Administrative Law Judge concludes that the Agencies did not demonstrate how or to what extent the damages attributed to the hypothetical plants

⁸⁹ Ex. 811 at 22 (Muller Surrebuttal).

⁹⁰ Ex. 606 at 6 (Desvousges Rebuttal).

⁹¹ Agencies Initial Exceptions at 3.

were or were not included in any of the recommendations the Agencies made for total CP externalities costs in this proceeding.

The Agencies clarify that the aggregations and summarized values used by Dr. Muller provided environmental costs for both the actual and hypothetical plants, and for example, in Table 6 of his direct testimony, reflects the six actual plants and 87 county hypothetical plants, so there is twice as much weight in the average values for those counties in which there were two modeled plants.

Staff believes this explanation does detriment to the Agencies arguments, while it clarifies what they did, having the ‘additional’ hypothetical plants in the averages weights the final value unnecessarily upward when there are six plants that have higher than *known* values in the average.

- ALJ Conclusion 20 - The Administrative Law Judge concludes that the Agencies failed to demonstrate by a preponderance of the evidence that the AP2 model, when evaluated according to the Boylan and Russell performance standards, generally performs at the highest standards of the performance goals when compared to CAMx and generally performs at adequate standards of the performance criteria when compared to real ambient monitor data available from the EPA.
- ALJ Conclusion 21 - The Administrative Law Judge concludes that Xcel demonstrated by a preponderance of the evidence that the Agencies’ performance evaluations are not reliable. The Agencies argued that, under the Boylan and Russell evaluation model guidance, annual and seasonal averages are appropriate because they are the degree of temporal resolution that is most significant for this proceeding. The Agencies asserted that annual and seasonal averages are most appropriate because the mortality concentration-response functions are based on annual data.⁹² The Administrative Law Judge concludes that it is not the purpose for which the evaluated data will be used that is significant for establishing the temporal resolution of the evaluated data. Rather, it is the nature of the evaluated data itself. The EPA modeling guidance speaks of “evaluating a model by using the observed native averaging times”⁹³ The model should produce accurate results, regardless of the use to which the data will be put. To interpret the Boylan and Russell model instructions to allow annual and seasonal data based on the inputs for concentration-response functions as the Agencies have done does not follow logically. Therefore, the Administrative Law Judge concludes that by using annual rather than 24-hour averages, the Agencies have compromised the validity of the Boylan and Russell performance evaluations.

The Agencies assert that Dr. Muller’s application of the performance standards can be relied upon to support the reasonableness and validity of the AP2 modeling results; however the Commission does not need to act on this Conclusion as the ALJ recommends the use of AP2 if a county-by-county approach is ordered.

⁹² See Finding 178 of this Report.

⁹³ Ex. 606 at 52 (Desvousges Rebuttal).

- ALJ Conclusion 22 - The Administrative Law Judge concludes that the Agencies failed to respond substantively to many of Xcel's additional concerns about the way in which the Agencies conducted the Boylan and Russell evaluations. Xcel raised specific and detailed questions, including:
 - why the Agencies failed to use graphical displays to validate performance evaluations;
 - why CAMx was presented in an annual average by grid and county;
 - why the Agencies relied on the EPA CAMx run, the hourly predictions of which were collapsed into annual average values;
 - why the comparisons were not presented in ambient concentration changes rather than absolute levels of ambient concentrations;
 - why no separate analyses were made to account for concerns that AP2 suffers as a model in its ability to measure such impacts beyond 50 kilometers; and
 - why use of 1990 meteorological data would not render the entire evaluation invalid.⁹⁴
- ALJ Conclusion 23 - With the exception of the response that meteorological data does not vary much when averaged over years, the Agencies' primary response to these issues was that the positive evaluations themselves were proof that none of the irregularities mattered. The Administrative Law Judge concludes that the Agencies' responses in this vein are circular and unpersuasive. If the evaluations were conducted at least in part outside the established guidelines, then it is not clear to what extent the results can be relied upon. Thus, the Administrative Law Judge concludes that the Agencies failed to demonstrate by a preponderance of the evidence that the results of the AP2 Boylan and Russell performance evaluations provided in this proceeding are reliable.

4. CAMx Photochemical Model – ALJ Conclusions

Regarding Xcel's CAMx model, the ALJ found that:

- ALJ Conclusion 24 - The Administrative Law Judge concludes that a preponderance of the evidence demonstrates that it took Xcel approximately four-and-a-half days to run a single quarterly simulation on CAMx. Given the computational demands of CAMx, the Administrative Law Judge concludes that it would not be practicable to use CAMx for approaches similar to those the Agencies and the CEOs used regarding the number of sources and source locations.

⁹⁴ See Finding 177 of this Report.

- ALJ Conclusion 25 - The Administrative Law Judge concludes that the preponderance of the evidence demonstrated that the CAMx model is capable of predicting impacts from CP emissions on ambient PM_{2.5} including states at least as distant from one another as Minnesota is to Florida, based on information available on the EPA's CSAPR information website.⁹⁵ The Administrative Law Judge further concludes that different CAMx models are configured at different spatial resolutions which affect the accuracy of the models' predictions.⁹⁶ Therefore, the Administrative Law Judge is not able to draw any conclusions regarding the degree of accuracy CAMx models are able to achieve when predicting the impact of emissions over long distances.
- ALJ Conclusion 26 - The Administrative Law Judge concludes that, although Xcel's decision to combine its CAMx runs of the Sherco and Marshall plants cast some doubt on the results of that analysis, Xcel's later testing of each plant alone confirmed Xcel's theory that the two plants did not have significant impacts on one another's damage costs.
- ALJ Conclusion 27 -The Administrative Law Judge concludes that Xcel failed to demonstrate the reliability of its CP damages costs because Xcel failed to recalculate those costs following the discovery of its accidental use of PM_{2.5} emissions data from its gas-fired Riverside facility in the emissions data used for the modeling of its hypothetical power plants. The Administrative Law Judge is unconvinced by Xcel's explanation that this error does not have an impact on the PM_{2.5} externality values proposed by Xcel because of the linear nature of increased ambient concentrations of PM_{2.5} from direct PM_{2.5} emissions.⁹⁷ Specifically, the Administrative Law Judge concludes that Xcel failed to demonstrate why the simultaneous discharge of SO₂ and NO_x, which were reported in the correct quantities, and their mingling with the PM_{2.5}, which was reported in a greatly diminished amount, would not have altered the results of the modeling in question.⁹⁸

This conclusion is discussed by Xcel in detail in their Initial Exceptions⁹⁹. Xcel argued that it did not need to recalculate values, as explained in their testimony, since the impact of primary PM_{2.5} is linear. Xcel noted that no other party took exception to this during the hearing process. Xcel proposed:

~~The Administrative Law Judge concludes that Xcel's failed to demonstrate the reliability of its CP damages costs because Xcel failed to recalculate those costs following the discovery of its~~ accidental use of PM_{2.5} emissions data from its gas-fired Riverside facility in the emissions data used for the modeling of its hypothetical power plants had not impact on their proposed PM_{2.5} externalities values. The Administrative Law Judge ~~is unconvinced by~~ understands Xcel's explanation that no recalculation is needed since this error does not have an impact on the PM_{2.5} externality

⁹⁵ Ex. 620 (EPA CSAPR spreadsheet).

⁹⁶ Ex. 119 at 14 (Marshall Surrebuttal).

⁹⁷ Ex. 609 at 12 (Desvousges Surrebuttal).

⁹⁸ *Id.*

⁹⁹ Xcel Initial Exceptions, at 19.

values proposed by Xcel because of the linear nature of increased ambient concentrations of PM_{2.5} from direct PM_{2.5} emissions.¹⁰⁰ Specifically, the Administrative Law Judge concludes that Xcel failed to demonstrate why the simultaneous discharge of SO₂ and NO_x, which were reported in the correct quantities, and their mingling with the PM_{2.5}, which was reported in a greatly diminished amount, would not have altered the results of the modeling in question.¹⁰¹

- ALJ Conclusion 28 - The Administrative Law Judge concludes that CAMx is a reliable, established PGM, and would be appropriate to use in this matter, if the Commission chooses to limit the sources and source locations.

5. Staff Discussion

Using the ALJ Report as a starting point, staff believes that first, the InMAP model likely should not be considered further as reasonable model in this proceeding, the Agencies and Xcel provided sufficient evidence that their models were more reasonable choices. Following, the AP2 model appears to be an option if the Commission wishes to order more prescriptive guidelines for remodeling of emissions and further analysis. Additionally, the ALJ Report questions the applicability of the AP2 model beyond 50 km and only recommends its use if the Commission finds that a geographic scope should be limited to Minnesota. The Agencies responded to these concerns in exceptions providing what appears to be additional information (potentially not already in the record¹⁰²) on the *EPA Guideline on Air Quality Models* and applicability of that guidance to other models.¹⁰³

Last, the ALJ Report found two flaws with the CAMx modeling, first the use of the Riverside data in lieu of the Sherco PM_{2.5} emissions, and her critique that Xcel's three-tiered approach should be expanded to five or six tiers. However she recommends this model as the most reliable on the record and goes so far as to suggest it be used for nationwide modeling. Staff questions whether these concerns are insurmountable, based on the record evidence, if the Commission assumes it should be approving a value versus ordering guidelines for future modeling.

G. Ambient Pollutants and Impacts to Consider / NAAQS

1. Background

The EPA is responsible for setting air quality standards to protect public health, with an adequate margin of safety. In the original externalities record, parties argued that as long as emissions do not cause ambient air concentrations to exceed the NAAQS, there can be no damages or costs to

¹⁰⁰ Ex. 609 at 12 (Desvousges Surrebuttal).

¹⁰¹ *Id.*

¹⁰² As of the submittal of these papers, staff is still reviewing the record to see whether the information provided in exceptions was previously submitted or whether it is new.

¹⁰³ Agencies Initial Exceptions at 11.

the environment. At that time, the Commission found that the EPA had been unable to keep the NAAQS updated to reflect the latest scientific knowledge. The Commission also found that the standards are currently not set at no-cost levels. The Commission concluded that the record before it more dependably reflected environmental costs in Minnesota.

On this record, MLIG (and to a degree Xcel) argued that the science is uncertain regarding the impacts of PM_{2.5} at levels lower than the NAAQS standard of 12 µg/m³. The Agencies and CEOs argue that the impacts from PM_{2.5} are linear, and there has been no threshold established that is deemed to have no impact. The ALJ agreed (Conclusion 54).

2. ALJ Recommendations and Exceptions

The ALJ concluded:

- ALJ Conclusion 51 - The Administrative Law Judge concludes that the preponderance of the evidence demonstrates that the ambient air concentration of PM_{2.5} in Minnesota and Wisconsin was generally under 12 µg/m³ from 2012 to 2014.¹⁰⁴
- ALJ Conclusion 52 - The Administrative Law Judge concludes that a preponderance of the evidence demonstrates that the EPA NAAQS standard for PM_{2.5} is currently 12 µg/m³.¹⁰⁵
- ALJ Conclusion 53 - The Administrative Law Judge concludes that a preponderance of the evidence demonstrates that the EPA Administrator's decision regarding the NAAQS standards is based on a combination of science and policy judgments, through which she weighs an acceptable level of risk against an adequate level of protection of public health.¹⁰⁶
- ALJ Conclusion 54 - The Administrative Law Judge concludes that a preponderance of the evidence demonstrates the relationship between chronic exposure to PM_{2.5} and all-cause cardiovascular and lung-cancer mortality is linear without a threshold.¹⁰⁷

Xcel proposed the following modification:

ALJ Conclusion 54 - The Administrative Law Judge concludes that a preponderance of the epidemiological evidence demonstrates the relationship between chronic exposure to PM_{2.5} and all-cause cardiovascular and lung-cancer mortality is linear down to 8 µg/m³ without a threshold. However, research has not yet determined whether a linear concentration-response function continues to apply at levels

¹⁰⁴ See Finding 278 of this Report.

¹⁰⁵ See Findings 287-288 of this Report.

¹⁰⁶ See Findings 288-290 of this Report.

¹⁰⁷ See Findings 297, 299, 301, 303-304 of this Report.

below 8 $\mu\text{g}/\text{m}^3$; all Parties calculated changes in ambient concentrations level of between 0 and 1 $\mu\text{g}/\text{m}^3$.¹⁰⁸

The Agencies argued that Xcel's proposed confuses ambient concentrations with marginal changes in the last sentence.¹⁰⁹

- ALJ Conclusion 55 - The Administrative Law Judge concludes that a preponderance of the evidence demonstrates that the CEOs, the Agencies and Xcel all met their burdens of demonstrating that it is appropriate to calculate mortality and morbidity damages for emissions of $\text{PM}_{2.5}$ in Minnesota, even if the ambient concentration of $\text{PM}_{2.5}$ is below 12 $\mu\text{g}/\text{m}^3$.¹¹⁰
- ALJ Conclusion 56 - The Administrative Law Judge concludes that a preponderance of the evidence that Minnesota's compliance with the NAAQS does not reduce CP damages associated with human mortality to zero.¹¹¹

3. Staff Discussion

Staff questions the reasonableness of attempting to calculate externality values for a subset of a federally regulated pollutant; a value below the NAAQS standards, but above the level in which damages are proven to occur (from this record appears to be argued by parties at 8 $\mu\text{g}/\text{m}^3$).

The Agencies in reply exceptions argued that absence of evidence doesn't equate to evidence of absence, to which staff agrees. However, to assume that the Commission can set damage cost values with any level of precision that adequately reflects actual damage costs of a pollutant (below what the EPA has deemed generally protective of human health and the environment and above what science has proven to be measureable and harmful), in a manner more precise and timely than the EPA can revise its standards (which are required to be reviewed on a five-year basis) seems far afield. However, the ALJ, and most parties, advocate for an externality value for $\text{PM}_{2.5}$.

XII. Staff Discussion

After review of the record, staff believes that there is balance that needs to be evaluated in this docket. To what extent should the Commission rely on this record to make a decision, and/or to what extent should it order additional analysis and development to potentially obtain more accurate values. In the previous case, there was attention given to the inherent uncertainty, practicability to obtain precision, and assumptions (or concessions) that had to be made that staff believes are relevant here, and as discussed above.

¹⁰⁸ See Findings 297, 299, 301, 303-304 of this Report.

¹⁰⁹ Agencies Reply Exceptions.

¹¹⁰ See Finding 301 of this Report; Minn. Stat. § 216B.2422, subd. 3.

¹¹¹ See Finding 302 of this Report.

For the most part, and to differing degrees, the ALJ has found issues with all three parties recommended values in that she could not recommend the Commission adopt any of the proposed values without further analysis or modifications to their method by which they were reached. Instead, she offered modifications and different parameters for future model iterations and runs to calculate externality values.

Staff believes the Commission has several options available to it at this time. It could, as the ALJ suggested, stipulate additional modeling parameters and guidance to parties to request further modeling iterations. Taking that approach, the Commission could select one of the two modeling options offered by the ALJ – either the five or six tiered version of the Xcel approach using CAMx, or the Agencies county-level data approach using AP2. Both of these options would require rerunning some levels of emissions modeling. Staff views the potential changes to be made in two parts, the emissions modeling and the later calculations (the concentration response function and the VSL factors). In the rerunning of any modeling, staff believes additional record development and comment periods would be needed to ensure that all parties could comment on the inputs to the models and to ensure the parameters were set correctly, Xcel goes so far to argue that additional contested case procedures are warranted and staff believes that could be a potential outcome.¹¹² However, later calculations, the concentration response function and VSL would be less involved and they are relatively simple calculations (and not require additional emissions modeling).

Based on the record before it, staff also believes the Commission has another options available to it, to adopt the values put forth by Xcel as the best available values on this record. While there are concerns about the use of the Riverside data in lieu of the Sherco PM_{2.5} data, and recommendations to increase the number of emission sources in the CAMx model; staff believes 1) Xcel appropriately explained and provided information supporting how they adjusted and corrected for this Riverside data both during the proceeding and in exceptions, and 2) adding different tiers of emission sources would potentially create a ‘better’ value, but not one proposed on the record.

Another option, if the Commission views the record ‘as-is’, would be to not adopt any value as supported by the record. Staff believes that any of the options proposed above are reasonable.

¹¹² Xcel Reply Exceptions at 3.

XII. Commission Decision Options

Note to Commissioners: The decision options as presented below clearly do not reflect all the potential options available to the Commissioners. Staff intends to work with Commissioners individually to formulate decision options that would best support their position.

Geographic Scope and/or Emission Source Locations

The Commission could make early findings on the proper scope of emission sources and geographic scope, or the Commission could move past this decision and make decision based on the record evidence, below.

Value of Statistical Life

1. \$7.7 million (ALJ Recommendation, agreed to by the Agencies)
2. EPA's VSL (updated to reflect current dollars) (CEOs and Agencies)
3. Adopt a range of \$4.1 to \$7.7 million (Xcel)
4. Take some other action

Concentration Response

5. 6.8% (ALJs Recommended Percent) or
6. 6.0 to 7.8% (ALJ Recommended Range, Xcel, Agencies)
7. 7.8% to 14% (CEOs)

Modeling and Outcomes

8. Adopt the ALJ's recommendation to use CAMx approach to modeling externality values using the CAMx model and request further comment on the appropriate expansion of ranges of the rural category.

Upon the Commission's decision of the appropriate additional rural categories, the Commission will request Xcel [or some other party] rerun the CAMx Model using the additional source categories:

Adopt a model configuration that provides a five- or six-tiered version of Xcel's three-tiered proposed sources and source locations. The Administrative Law Judge recommends that the additional tiers incorporate factors such as nearby topography, vegetation, buildings, etc. consistent with the Agencies' recommendations. The tiers could accomplish this by including variations on the rural category to account for rural settings that are isolated versus rural settings that are less so, and possibly a "small town" category. This would enable the Commission to gain additional information beyond the three categories Xcel proposed. If the Commission chooses this option, the Administrative

Law Judge respectfully recommends that the Commission choose the CAMx model, if the Commission finds that the CAMx model would be practicable to use with this somewhat expanded scope. The Administrative Law Judge recommends the CAMx model because it is more reliable than AP2.

9. Adopt the ALJ's recommendation to use the AP2 approach to modeling, and request the Department rerun the AP2 model to only reflect active EGUs in out-of-state locations, excluding EGUs located in eastern Wisconsin, Michigan, and Illinois. The county-specific values should not be combined or averaged.

Adopt a model configuration that includes all 87 counties in Minnesota, but only out-of-state sources that reflect active EGUs in the out-of-state locations. The Administrative Law Judge recommends that county-specific information not be combined or averaged, but used as the CEOs recommended it be used. In addition, the Administrative Law Judge recommends that the Commission exclude out-of-state sources located in eastern Wisconsin, Michigan and Illinois. If the Commission chooses this option, or some variation of it that is similar in scope and size, the Administrative Law Judge recommends that the Commission choose the AP2 model, which is generally recognized as a reliable model and would be capable of modeling the much larger number of modeling runs needed with this configuration.

10. Adopt Xcel's externality values.
11. Adopt CEO's externality values.
12. Adopt the Agencies' externality values.
13. Take no action and retain the existing values.

Application of Values

14. [If new values are adopted] Require utilities to apply the values in IRP and CN proceedings to all emission sources located within Minnesota and 200 miles of the state border, in the contiguous US.
15. Take some other action.

Minn. agency raises state's CO2 values, rejects federal cost of carbon

EXTRA

Friday, July 28, 2017 11:26 AM ET

By Stephanie Tsao

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The Minnesota Public Utilities Commission approved a proposal from Commissioner Dan Lipschultz to set a range of carbon cost values instead of adopting carbon costs set by the federal government.

By a 3-2 vote, the commission voted on July 27 to approve the second option [proposed \(/web/client?auth=inherit#news/docviewer?KeyProductLinkType=2&mid=40259848\)](/web/client?auth=inherit#news/docviewer?KeyProductLinkType=2&mid=40259848) by Lipschultz that sets an average cost of carbon in 2020 at \$26.05/ton, rising to an average of \$45.15/ton in 2050. Lipschultz called the values a "substantial" change from the current range of carbon costs in Minnesota that are between 44 cents/ton and \$4.46/ton.

The values are important to the state in terms of resource planning and deciding between fossil fuel resources and carbon-free sources, the commission indicated during the meeting.

In addition, the commission voted unanimously to adopt values proposed by [Xcel Energy Inc. \(/web/client?auth=inherit#company/profile?KeyProductLinkType=2&id=4025308\)](/web/client?auth=inherit#company/profile?KeyProductLinkType=2&id=4025308), known legally as [Northern States Power Co. - Minnesota \(/web/client?auth=inherit#company/profile?KeyProductLinkType=2&id=4057754\)](/web/client?auth=inherit#company/profile?KeyProductLinkType=2&id=4057754), for environmental costs related to emissions from fossil fuel power plants: sulfur dioxide, nitrogen oxides and dust particles known as particulate matter. According to [briefing papers \(/web/client?auth=inherit#news/docviewer?KeyProductLinkType=2&mid=39319421\)](/web/client?auth=inherit#news/docviewer?KeyProductLinkType=2&mid=39319421) from PUC staff dated July 13, Xcel Energy proposed SO2 values from \$3,427/ton up to \$14,382/ton. NOx values ranged from \$1,985/ton to \$7,893/ton. For the first time, the commission placed a value on fine particulates, known as PM 2.5, which the U.S. Environmental Protection Agency defines as dust particles tinier than a grain of sand. For PM 2.5, Xcel Energy proposed environment costs between \$3,437/ton and \$25,137/ton. Fine particulates, according to the EPA, can cause the formation of haze.

Regarding carbon, the commission had to decide whether the federal social cost of carbon, which was determined by an interagency working group during the Obama administration, is the best available measure for setting the state's own carbon values. The federal social cost of carbon attempts to quantify, in dollars per ton, the societal impact of emitting a ton of carbon dioxide. The interagency working group in 2013 set the value in the range of \$40/ton of CO2 to \$48/ton, according to EPA [guidelines \(/web/client?auth=inherit#news/docviewer?KeyProductLinkType=2&mid=35180965\)](/web/client?auth=inherit#news/docviewer?KeyProductLinkType=2&mid=35180965). But the federal values are no longer up-to-date given that the Trump administration disbanded the working group, according to separate staff [briefing papers \(/web/client?auth=inherit#news/docviewer?KeyProductLinkType=2&mid=39451299\)](/web/client?auth=inherit#news/docviewer?KeyProductLinkType=2&mid=39451299) dated July 21. Plus, the federal cost of carbon was intended for regulatory impact analysis, not state resource planning, commissioners noted during the meeting.

Using the federal social cost of carbon gained the backing of the Minnesota Department of Commerce, state Department of Pollution Control Agency and various environmental and health groups such as the Minnesota Center for Environmental Advocacy, Sierra Club, Fresh Energy and Doctors for a Healthy Environment.

Power suppliers including Xcel Energy, [Great River Energy \(/web/client?auth=inherit#company/profile?KeyProductLinkType=2&id=4060312\)](#), [ALLETE Inc. \(/web/client?auth=inherit#company/profile?KeyProductLinkType=2&id=4022309\)](#) subsidiary [Minnesota Power Inc. \(/web/client?auth=inherit#company/profile?KeyProductLinkType=2&id=4061513\)](#), and [Otter Tail Power Co. \(/web/client?auth=inherit#company/profile?KeyProductLinkType=2&id=4147257\)](#) and large industrial end-users who are members of the Minnesota Large Industrial Group proposed alternatives or modifications to the federal social cost of carbon.

During deliberations and before the commission decided on what values to use, Commissioner John Tuma indicated his concern that the state's carbon costs might become "institutionalized," and that they might be misused in the future or in other jurisdictions.

"I am not a big fan of nuclear power, and I don't think the way these numbers were used in other jurisdictions, particularly the federal cost of carbon, were wise uses of those numbers," Tuma said, highlighting [Illinois' \(/web/client?auth=inherit#news/article?KeyProductLinkType=2&id=41338887\)](#) use of the social cost of carbon for zero-emission credits that serve as an incentive for nuclear power. "I want to be very careful that we design the decision on this particular pollutant, as we go to develop the range for future generations, that it is used appropriately."

Commission Chair Nancy Lange urged her fellow commissioners to think carefully because the carbon costs will factor into customer rates. "I don't have a problem setting climate values using the federal social cost of carbon, but we have to recognize the degree of uncertainty because like natural gas prices, it is an economic input into the model," Lange said. (Minnesota PUC Docket E999/CI-14-643)

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