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**VIA E-FILING AND U.S. MAIL**

The Honorable Judge LauraSue Schlatter  
Office of Administrative Hearing  
600 North Robert Street  
P.O. Box 64620  
St. Paul, MN 55164-0620

**Re: In the Matter of the Investigation into Environmental and Socioeconomic Costs  
Under Minn. Stat. § 216B.2422, Subd. 3  
Docket No. E-999/CI-14-643  
OAH Docket No. 80-2500-31888**

Dear Judge Schlatter:

Enclosed for filing please find the following documents on behalf of the Minnesota Large Industrial Group ("MLIG"):

1. MLIG's Post-Hearing Brief Regarding Phase I (Co<sub>2</sub> Track); and
2. Certificate of Service.

Very truly yours,

STOEL RIVES LLP

/s/ Marc A. Al

Marc A. Al

Enclosures

cc: Service List (via e-filing)

**BEFORE THE MINNESOTA OFFICE OF ADMINISTRATIVE HEARINGS**  
600 North Robert Street  
St. Paul, Minnesota 55101

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

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

MPUC DOCKET NO. E-999/CI-14-643  
OAH Docket No. 80-2500-31888

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**MINNESOTA LARGE INDUSTRIAL GROUP'S  
POST-HEARING BRIEF REGARDING PHASE I (CO<sub>2</sub> TRACK)**

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## INTRODUCTION

Moved by great concern about the impact on electricity rates of the requested adoption of the federal government’s Interagency Working Group’s federal social cost of carbon (“FSCC” or generically “SCC”) for use in Minnesota resource planning and other resource-selection proceedings under Minn. Stat. § 216B.2422,<sup>1</sup> the Minnesota Large Industrial Group (“MLIG”) [intervened](#) in this proceeding on November 4, 2014. A number of members of the MLIG are energy-intensive trade-exposed customers as that term is defined in Minn. Stat. § 216B.1696, whose energy costs can constitute more than 30 percent of their total production costs.<sup>2</sup>

This proceeding is somewhat unique in that the large industrials also represent the economic interests of much smaller commercial ratepayers and regular households. While the Department of Commerce is a party to the proceeding, the Attorney General’s Office as consumer advocate is not. And by advocating for the adoption of only a 3% discount rate rather than the entire FSCC range recommended by the federal

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<sup>1</sup> See [October 9, 2013, Memorandum in Support of Clean Energy Organizations’ Motion to Update Externality Values for Use in Resource Decisions in Commission Docket No. E-999/CI- 93-583](#) at 18-19; and [June 10, 2014, comments of the Minnesota Department of Commerce, Division of Energy Resources, and the Minnesota Pollution Control Agency in Commission Docket No. E-999/CI- 93-583](#) at 9-10 (recommending that the Commission adopt the federal government’s SCC and recommending that the Commission adopt the central 3% discount factor values as the Commission’s CO<sub>2</sub> externality value).

<sup>2</sup> Hearing Transcript (“Tr.”) Vol. 4 at 18:2-10 (Martin) (also recommending that “the Commission may wish to consider ways to address or to mitigate rate impacts on specific customer classes.”).

government's Interagency Working Group on the Social Costs of Carbon ("IWG"),<sup>3</sup> the Department is asking the Commission to adopt only the high end of the FSCC range, which high end exceeds the low end of the range by a factor 3.5 (*compare* Ex. [307](#) (Table 4A) lines 1 (FSCC value of \$42.14 at 3% discount rate) and 4 (FSCC value of \$12.03 at 5% discount rate)).<sup>4</sup> The MLIG is troubled by what appears to be a disconnect between the Department's position in this docket and the ultimate rate impact that position could have if adopted by the Commission.

The MLIG is particularly concerned because the FSCC was designed for different purposes, where accuracy is much less important. In the federal context, the FSCC is to be used to determine whether benefits of a proposed regulation outweigh its costs (*i.e.*, whether to regulate). In the Minnesota context, the environmental cost value ("ECV") of CO<sub>2</sub> is used as a specific dollar-per-ton input that is a very important factor in determining which resource mix (consisting of coal-fired electric generation plants, gas-fired electric generation plants, wind-powered electric generation, solar electric generation, and hydro) will be deemed optimal to service the needs of utilities and their customers (*i.e.*, how to regulate).

The MLIG is further concerned because the damages functions in the FSCC modeling suffer from significant deficits, many of which arise out of an earnest and understandable desire to run modeling for the entire time it takes a ton of CO<sub>2</sub> emitted

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<sup>3</sup> See [June 10, 2014, comments of the Minnesota Department of Commerce, Division of Energy](#) at 10.

<sup>4</sup> A copy of Ex. [307](#) is attached as the last page of this Brief.

now or in the near future to degrade, which horizon is more than 200 years. However, while one can reliably model the degradation of CO<sub>2</sub> over that timeframe, reliably predicting and modeling world population, GDP, carbon use, adaptation, and mitigation is impossible over that same timeframe. For example, to come up with endogenous input for the models, the IWG had to extend the horizon of the best available modeling effort attempting to develop realistic scenarios specific to the inherently long-run concern of climate policy (EMF 22) by 200 years, and the IWG had to modify the PAGE model to accommodate an additional 100 years.<sup>5</sup> The extension of the input scenarios had the effect that four of the five input scenarios model carbon consumption over the time of the model runs in a way that is inconsistent with physical facts. The emissions now assumed by those four models greatly exceed the CO<sub>2</sub> emissions that could come about from the combustion of all current estimates of global fossil fuel reserves, with the MERGE input scenario exceeding the available remaining worldwide carbon reserves by factors 4.5 to 8.5.<sup>6</sup>

The MLIG addresses the two questions posed by the Commission, namely whether the FSCC is the best available measure of the ECV for CO<sub>2</sub> and, if not, what is. The MLIG answers the first question in the negative, using this Brief to explain the faulty analysis of the IWG and those parties to this proceeding who support adoption of the FSCC. This includes Xcel Energy, which admits that its “alternative” statistical analysis

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<sup>5</sup> Ex. [302](#) (Smith Direct report) at 66.

<sup>6</sup> *Id.* at 68 (citations omitted).

is effectively identical to the FSCC's range under the 3% and 5% discount rates for resource-planning purposes. The MLIG then provides an overview of a defensible ECV for CO<sub>2</sub>, assuming the Commission desires a damage-cost ECV for CO<sub>2</sub>.

In this Post-Hearing Brief, the MLIG respectfully submits that intervenors Doctors for a Healthy Environment and the Clean Energy Business Coalition have not introduced admissible foundational evidence to support adoption of the FSCC, and that the IWG's FSCC is neither "reasonable" nor "the best available measure to determine the environmental cost of CO<sub>2</sub>." The MLIG sets forth the parties' positions, and explains that the IWG did not develop the FSCC for state resource planning, and why the FSCC is not suitable for the purpose intended in Minnesota without—at a minimum—modifications.

The MLIG also shows how the IWG's FSCC is out of date with respect to the equilibrium climate sensitivity ("ECS") and that the IPCC's 2013 Fifth Assessment Report explains that the new studies underlying a lowering of the low end of the ECS range "suggest a best fit to the observed surface and ocean warming for ECS values in the lower part of the *likely* range." (Ex. 405 [part 36](#) at 1111, first full paragraph (italics in original)). Given Dr. Lindzen's uncontroverted testimony that Roe and Baker distributions give special emphasis to high values<sup>7</sup> and given a potential 57% to 60% overstatement in damages values if one uses an excessive ECS, straight adoption of the FSCC values for Minnesota PUC purposes would be arbitrary and capricious. The

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<sup>7</sup> Tr. Vol. 2A at 38:6-7 (Lindzen).



Commission in 1997 rejected the application of U.S. Environmental Protection Agency data on the basis that it was outdated,<sup>8</sup> and the MLIG respectfully submits that the ALJs and the Commission should do so in this proceeding with respect to the IWG’s FSCC.

The MLIG next sets forth how IWG’s FSCC values are based on unreliable damage functions for temperature increases above 3°C and that those damage functions not only lack empirical support but “cannot provide meaningful estimates of the SCC”<sup>9</sup> even if they are the best models available for damages calculations up to 2100.

The overstatement of damages in the IWG’s FSCC is compounded by its use of an incorrect marginal ton. It is inappropriate to assume that a particular ton of CO<sub>2</sub> emitted in the near future would be the last ton to be decided on as part of a 300-year “business as usual” baseline of otherwise virtually unconstrained future emissions, since many of the tons emitted that contribute to the FSCC will not be emitted until much later than the Minnesota tons in question and by others than Minnesota, while the carbon emitted in Minnesota is no more or less harmful than carbon emitted elsewhere and is also no more or less harmful than any of the tons assumed to be emitted in the future.<sup>10</sup>

This Post-Hearing Brief next addresses the IWG’s selection of discount rates, which is an issue that the IWG admits “raises highly contested and exceedingly difficult

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<sup>8</sup> See [Order Establishing Environmental Cost Values, MPUC Docket No. 93-583, dated Jan. 3, 1997](#) at 16-17.

<sup>9</sup> Ex. [304](#) (Smith Surrebuttal) at 10:22-11:6 (*citing* Pindyck, R. 2013. “Climate Change Policy: What Do the Models Tell Us? *Journal of Economic Literature*, 51(3): 860-872 (at p. 869)).

<sup>10</sup> See Ex. [300](#) (Smith Direct) at 20:7-21:1.

questions of science, economics, philosophy, and law.”<sup>11</sup> The MLIG shows, based on empirical data and the models, that the rejection of a 2.5% discount rate will not lead to the current generation taking advantage of future generations, and that by 2300, when the largest amount of climate impact (with virtually unreduced business-as-usual emissions) will have occurred, consumption will be between 7 and 25 times higher than today even after absorbing the impacts of temperature change.

The MLIG also shows why the IWG used a geographic scope that is not appropriate for Minnesota resource planning in the absence of reciprocity, and that the use of the IWG’s 95<sup>th</sup> percentile FSCC value over-weights uncertain risks relative to more certain risks. The MLIG accordingly urges the ALJs and the Commission to carefully distinguish between risk and uncertainty; to not fall for the Ellsberg Paradox;<sup>12</sup> and to reject reliance on the 95<sup>th</sup> percentile damages calculations.

In the second part of the Post-Hearing Brief, the MLIG shows that Xcel Energy has not provided a viable alternative to the IWG’s environmental cost value for CO<sub>2</sub>.

In the last part of this Brief (pp. 67-86), the MLIG summarizes why Dr. Smith has provided a practicable alternative to the IWG’s environmental cost value for CO<sub>2</sub> if the Commission decides to rely on a damage cost approach. The Brief addresses the proposed framing-assumption adjustments to the damages horizon, sets forth the MLIG’s basis for an alternative discount rate (5.66%), addresses the correct marginal ton (the first

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<sup>11</sup> Ex. [100](#) at Schedule 2 (July 2010 IWG Technical Support Document) at 17.

<sup>12</sup> *See infra* at 59-60.

and average tons), the correct geographic scope (Minnesota damages or, at most, U.S. damages if the Commission were to provide 100% altruistic weight to all other U.S. states), and shows why the ALJs and the Commission should express the ECV of CO<sub>2</sub> in net tons to account for leakage.

After making these alterations to the FSCC, Dr. Smith's proposed range for emissions in the year 2020 is \$1.62 to \$5.14 (in 2014 dollars per net metric ton). The low value is based on modeling damages from the first ton emitted, 5 percent discount rate, U.S. damages, and a modeling horizon to the year 2100.<sup>13</sup> The high value is based on the average of first ton and last ton emitted, 3 percent discount rate, U.S. damages, and a modeling horizon to year 2140.<sup>14</sup> Application of Minnesota-only damages reduces the amounts to \$0.37 per net metric ton of CO<sub>2</sub> (2010 damage value in 2007 dollars), applying the IWG's GDP-scaling to the highest FSCC estimate.

The MLIG respectfully submits that if the Commission desires to protect important Minnesota values such as the affordability of energy, that it maintain the conservative approach to the environmental cost of carbon recommended by ALJ Klein and adopted in the Commission's January 3, 1997, [Order Establishing Environmental Cost Values](#). As applied, the MLIG respectfully submits that the ALJs and the Commission should adopt a range for the environmental cost value of CO<sub>2</sub> of \$0.37 to

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<sup>13</sup> See Tr. Vol. 2A at 60:17-63:3; Ex. [307](#).

<sup>14</sup> *Id.*

\$5.14 per net metric ton (in 2014 dollars).<sup>15</sup>

## ANALYSIS

### I. BURDEN OF PROOF

#### A. Procedural posture and applicable burden of proof

In 1993, the Legislature enacted Minn. Stat. § 216B.2422, subd. 3,<sup>16</sup> to require the Commission to “quantify and establish a range of environmental costs associated with each method of electricity generation.” The statute requires utilities to use the values in Commission proceedings “in conjunction with other external factors, including socioeconomic costs, when evaluating and selecting resource options . . . .” The Commission established interim cost values in 1994, and final values in 1997, for Sulfur Dioxide (SO<sub>2</sub>), Carbon Monoxide (CO), Carbon Dioxide (CO<sub>2</sub>), Nitrogen Oxides (NO<sub>x</sub>), Lead (Pb), and particulate matter less than 10 microns in diameter (PM<sub>10</sub>).<sup>17</sup> In 2001, the Commission determined that the values should increase to account for inflation,<sup>18</sup> which

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<sup>15</sup> If, on the other hand, the Commission desires to afford 100 percent altruistic weight to all other U.S. States, the MLIG supports Dr. Smith’s proposed range for emissions in the year 2020 of \$1.62 to \$5.14 (in 2014 dollars per net metric ton).

<sup>16</sup> 1993 Minn. Laws Ch. 356, § 3.

<sup>17</sup> See *In the Matter of Quantification of Environmental Costs Pursuant to Laws of Minnesota 1993, Chapter 356, Section 3*, Docket No. E-999/CI-93-583, [Order Establishing Environmental Cost Values](#) (January 3, 1997), and [Order Affirming in Part and Modifying In Part Order Establishing Environmental Cost Values](#) (July 2, 1997).

<sup>18</sup> See *Order Updating Externality Values and Authorizing Comment Periods on CO<sub>2</sub>, PM<sub>2.5</sub>, and Application of Externality Values to Power Purchases* (May 3, 2001).

has been done ever since.<sup>19</sup>

The Clean Energy Organizations (“CEOs”) filed a petition alleging that environmental cost values “are no longer supported by scientific evidence,” and requested that the investigation be reopened.<sup>20</sup> After considering arguments for and against the petition, the Commission determined that the scientific evidentiary support for the existing values “had been reasonably called into question,” and reopened its investigation.<sup>21</sup>

On October 15, 2014, the Commission held that it would investigate the appropriate cost values for PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>x</sub>, and CO<sub>2</sub>. The Commission further held that it “would not further investigate at that time the environmental costs of other greenhouse gasses such as methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF<sub>6</sub>).” Instead, the Commission held that “[b]ecause CO<sub>2</sub> represents 99% of greenhouse gas emissions, an accurate environmental cost value for CO<sub>2</sub> will account for almost all greenhouse gas costs. This will result in a more manageable proceeding and allow the parties to focus their

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<sup>19</sup> See, e.g., [Notice of Updated Environmental Externalities Values, PUC Docket Nos. E-999/CI-93-583 and E-999/CI-00-1636, May 27, 2015.](#)

<sup>20</sup> See [October 9, 2013, Memorandum in Support of Clean Energy Organizations’ Motion to Update Externality Values for Use in Resource Decisions in Commission Docket No. E-999/CI- 93-583](#) at 18-19.

<sup>21</sup> [Order Reopening Investigation and Convening Stakeholder Group to Provide Recommendations for Contested Case Proceeding](#), Docket No. E-999/CI-00-1636 (February 10, 2014).

resources.”<sup>22</sup>

The Minnesota Department of Commerce and the Minnesota Pollution Control Agency (jointly the “Agencies”) recommended the immediate adoption of the Federal Social Cost Of Carbon (“FSCC”) as developed by a federal Interagency Working Group (“IWG”),<sup>23</sup> which recommendation the Commission rejected as premature.<sup>24</sup> The Commission believed that a contested case proceeding was necessary to fully consider the CEOs’ and the Agencies’ proposed CO<sub>2</sub> cost values. Instead, the Commission asked the Administrative Law Judge (“ALJ”) to determine “whether the Federal Social Cost of Carbon is reasonable and the best available measure to determine the environmental cost of CO<sub>2</sub> and, if not, what measure is better supported by the evidence.”<sup>25</sup>

On March 27, 2015, ALJ Schlatter ruled that “no special burden of proof attaches to proceedings under Minn. Stat. § 216B.2422, and that any party advocating a position must support that position by a preponderance of the evidence.”<sup>26</sup> Accordingly, “[a] party or parties proposing that the Commission adopt a new environmental cost value for

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<sup>22</sup> [Notice and Order for Hearing dated Oct. 15, 2014.](#)

<sup>23</sup> [See June 10, 2014, comments of the Minnesota Department of Commerce, Division of Energy Resources, and the Minnesota Pollution Control Agency in Commission Docket No. E-999/CI- 93-583](#) at 9-10 (recommending that the Commission adopt the federal government’s SCC and recommending that the Commission adopt the central 3% discount factor values as the Commission’s CO<sub>2</sub> externality value).

<sup>24</sup> [Notice and Order for Hearing dated Oct. 15, 2014](#) at 3-4.

<sup>25</sup> *Id.* at 4.

<sup>26</sup> [Order Regarding Burdens of Proof dated March 27, 2015](#) at 5 (*citing* Minn. Rules Part 1400.7300, subp. 5).

CO<sub>2</sub>, including the Federal Social Cost of Carbon, bears the burden of showing, by a preponderance of the evidence, that the value being proposed is reasonable and the best available measure of the environmental cost of CO<sub>2</sub>.<sup>27</sup> Conversely, “[a] party opposing a particular proposal need *only* demonstrate that the proponent of proposed value cannot meet the preponderance requirement, because the proponent’s evidence is flawed, or the proposal is impracticable.”<sup>28</sup> “Practicable” has been defined by the Commission in its January 3, 1997, [Order Establishing Environmental Cost Values](#), to mean “feasible” or “capable of being accomplished.”<sup>29</sup> “If the weight of the evidence is evenly balanced, for and against, the *opponent* has met its burden because the proponent will not have achieved the required preponderance of the evidence.”<sup>30</sup>

**B. Doctors for a Healthy Environment and the Clean Energy Business Coalition have not introduced admissible foundational evidence to support adoption of the FSCC**

In this proceeding, the Agencies, the CEOs, Doctors for a Healthy Environment, and the Clean Energy Business Coalition all advocated for adoption of the FSCC. As explained in detail below, the latter two did not introduce admissible foundational evidence to support adoption of the FSCC, however.

1. Doctors for a Healthy Environment

Doctors for a Healthy Environment relied on William N. Rom, M.D., M.P.H. to

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<sup>27</sup> [Order Regarding Burdens of Proof dated March 27, 2015](#) at 2, ¶ 1.

<sup>28</sup> *Id.* at 6 (emphasis added).

<sup>29</sup> [Order Establishing Environmental Cost Values](#) dated January 3, 1997, at 10-11.

<sup>30</sup> [Order Regarding Burdens of Proof dated March 27, 2015](#) at 6 (emphasis added).

support adoption of the FSCC as the environmental cost value for CO<sub>2</sub> in Minnesota. While Dr. Rom testified that exposure to PM<sub>2.5</sub> and ozone increases mortality and that warmer temperatures increase these mortality effects,<sup>31</sup> Dr. Rom acknowledged that the U.S. Environmental Protection Agency has standards for regulating ozone and PM<sub>2.5</sub>, that those standards are “designed to protect human health,” and that ozone and PM<sub>2.5</sub> levels have generally declined in the United States.<sup>32</sup> As is reflected in pre-filed testimony in the Criteria-Pollutant aspect of this proceeding, Minnesota is in “attainment” for PM<sub>2.5</sub>.<sup>33</sup> Dr. Rom further acknowledges that while there is harm from increased temperatures, there “would be a positive effect on less cold-related morbidity.”<sup>34</sup>

Dr. Rom further blamed forest fires for harm to human health, and testified that the toxicity of particles from forest fires is much greater than the particle toxicity from industry, power plants, and traffic.<sup>35</sup> Dr. Rom acknowledged, however, that he has no training to allow him to provide an expert opinion regarding the causal connection between CO<sub>2</sub> levels and forest fires, that “[i]t’s usually humans that cause forest fires, or lightning,” and that “establishing the relative causation between heat and wildfire

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<sup>31</sup> Ex. [500](#) (Rom Rebuttal) at 12, 17-18; Tr. Vol. 4 at 160:9-162:15 (Rom).

<sup>32</sup> Tr. Vol. 4 at 166:21-167:18 (Rom).

<sup>33</sup> See [rebuttal testimony of expert Dr. Roger O. McClellan](#) at Appendix 2 at 9. Minnesota is also in attainment for ozone.

See [http://www3.epa.gov/airquality/airdata/ad\\_rep\\_con.html](http://www3.epa.gov/airquality/airdata/ad_rep_con.html);  
<http://www.usa.com/minneapolis-mn-air-quality.htm#epaozone>.

<sup>34</sup> Tr. Vol. 4 at 163:1-17; 166:15-18 (Rom).

<sup>35</sup> *Id.* at 162:16-25.



pollution is difficult.”<sup>36</sup> Dr. Rom further acknowledged that he has no training to comment on any relationship between water use for irrigation in the United States on the one hand and wildfires on the other hand.<sup>37</sup>

Dr. Rom further testified that “heat has outweighed coal in mortality,”<sup>38</sup> that some health impacts are not included in the FSCC estimates, and that he believed “the \$37 figure per ton of CO<sub>2</sub> should be a lower limit.”<sup>39</sup> On the other hand, Dr. Rom acknowledged that breathing CO<sub>2</sub> does not cause asthma, that the integrated assessment models (“IAMs”) relied upon by the IWG (FUND, PAGE, and DICE) include numerous health-impact considerations, that he has no firsthand knowledge working with the IAMs, that he does not have any expertise on DICE, PAGE, or FUND, that he has no training as an economist or environmental economist, that he has no training in modeling, and that he has no training in meteorology or other sciences specifically related to the cause and effect between CO<sub>2</sub>, temperature, and positive and negative feedbacks.<sup>40</sup>

Most importantly, Dr. Rom does not “propose any specific value” in this proceeding, has not assigned any values to damages that he claims may not be included in the IAMs, and has not provided “any specific way of determining what the right [CO<sub>2</sub>

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<sup>36</sup> Tr. Vol. 4 at 168:24-170:15 (Rom); Ex. [500](#) (Rom Rebuttal) at 19.

<sup>37</sup> Tr. Vol. 4 (Rom) at 170:16-20.

<sup>38</sup> *Id.* at 163:1-17.

<sup>39</sup> *Id.* at 164:24-25; Ex. [500](#) (Rom Rebuttal) at 8-9.

<sup>40</sup> Tr. Vol. 4 at 165:1-166:3; Ex. [500](#) at 9.

externality] value should be in this proceeding.”<sup>41</sup> Accordingly, while Dr. Rom may be an eminent physician, his testimony shows that he was neither qualified to opine about the reliability, practicability, or appropriateness of the FSCC for application in the Minnesota regulatory context, such that Doctors for a Healthy Environment has failed to introduce admissible foundational evidence to support adoption of the FSCC as developed by the IWG. Accordingly, Doctors for a Healthy Environment failed to meet its burden of proof to show that the “value being proposed [by means of the FSCC value] is reasonable and the best available measure of the environmental cost of CO<sub>2</sub>,” as required by the March 27, 2015, [Burdens of Proof Order](#),<sup>42</sup> Minn. Rules Part 1400.7300, subp. 5, and *In re Quantification of Env'tl. Costs Pursuant to Laws of Minn. 1993, Chapter 356, Section 3*, 578 N.W.2d 794, 801 (Minn. Ct. App. 1998).

## 2. The Clean Energy Business Coalition

The Clean Energy Business Coalition relied on the testimony of Shawn Rumery and Chris Kunkle to support adoption of the FSCC as the environmental cost value for CO<sub>2</sub> in Minnesota. Mr. Rumery is the Director of Research at the Solar Energy Industries Association in Washington, D.C.<sup>43</sup> Mr. Rumery testified in pre-filed testimony that proper valuation of the costs associated with the environmental pollution generated by the electricity industry will create a more level playing field, sending the right signals to the market to promote non-CO<sub>2</sub> emitting energy technologies and thus ramping up

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<sup>41</sup> Tr. Vol. 4 at 165:1-7; 165:25-166:4.

<sup>42</sup> [Order Regarding Burdens of Proof dated March 27, 2015](#) at 2 and 6.

<sup>43</sup> Ex. [700](#) (Rumery Rebuttal) at 1.

industries that can create jobs, strengthen the economy, and help support a cleaner and healthier environment.<sup>44</sup>

Mr. Kunkle is a Regional Policy Manager for Wind on the Wires.<sup>45</sup> His pre-filed testimony was virtually identical to Mr. Rumery's, and again posited that proper valuation of the costs associated with the environmental pollution generated by the electricity industry will create a more level playing field, sending the right signals to the market to promote non-CO<sub>2</sub> emitting energy technologies and thus ramping up industries that can create jobs, strengthen the economy, and help support a cleaner and healthier environment.<sup>46</sup>

Stipulations were entered into the record with respect to both Mr. Kunkle and Mr. Rumery's testimony to the effect that neither has formal training in modeling or the climate science underlying the IWG, PAGE, FUND, and DICE modeling. (Exs. [437](#) and [438](#).) Neither Mr. Kunkle nor Mr. Rumery further sought to express an expert opinion about the fundamentals of the IWG's process in establishing a federal social cost of carbon. (*Id.*) Thus, neither expressed an expert opinion about (equilibrium) climate sensitivity, (*id.*), the appropriate discount rate to be used in this proceeding, (*id.*), the appropriate temporal scope or horizon for Minnesota's environmental cost of carbon values, whether it be the year 2100, 2140, or 2300, (Exs. [437](#) and [438](#)), nor about the appropriate geographic scope to be included in Minnesota's environmental cost of carbon

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<sup>44</sup> Ex. [700](#) (Rumery Rebuttal) at 2.

<sup>45</sup> Ex. [701](#) (Kunkle Rebuttal) at 1.

<sup>46</sup> *Id.* at 2; Tr. Vol. 5 at 15:21-31:16 (Kunkle).

values, whether it be Minnesota, the United States or a fraction thereof, or global or a fraction thereof. (Exs. [437](#) and [438](#).) Neither Mr. Kunkle nor Mr. Rumery expressed an expert opinion about the reliability of the models underlying the IWG’s modeling, to wit, PAGE, FUND, and DICE. (*Id.*)

While Mr. Kunkle and Mr. Rumery endorsed the concept of proper valuation of externalities associated with the electricity-generation industry, the importance of establishing the correct value is not in dispute; the question is what that value is or should be. But neither Mr. Kunkle nor Mr. Rumery could offer and neither sought to offer any opinion about the validity of the federal social cost of carbon values. (*Id.*) Instead, Mr. Kunkle broadly endorsed any higher environmental cost value for CO<sub>2</sub>, seeking testifying that “if the Commission adopts a more accurate value on cost externalities, the transition to a cleaner, flexible energy system will be accelerated, thus helping to shield Minnesota taxpayers from the price spikes associated with fossil fuels.”<sup>47</sup> Mr. Rumery’s and Mr. Kunkle’s testimony thus amounted to nothing more than an endorsement of the efficacy of renewable energy and renewable-energy policy, which type of testimony was properly held to be irrelevant to the issues in the case.<sup>48</sup>

Importantly, both Mr. Rumery and Mr. Kunkle stipulated, through counsel, that they could not and did not seek to offer any opinion about the best monetary amount to account for the costs or benefits of carbon emissions. (Exs. [437](#) and [438](#).) In the absence

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<sup>47</sup> Tr. Vol. 5 at 17:25-18:5 (Kunkle).

<sup>48</sup> [Third Prehearing Order dated April 16, 2015](#) at 2, ¶ 3.

of any proffered testimony about the validity or reliability of the FSCC and in the absence of any testimony about the best monetary amount to account for the costs or benefits of carbon emissions, the Clean Energy Business Coalition failed to meet its burden of proof to show that the “value being proposed [by means of the FSCC value] is reasonable and the best available measure of the environmental cost of CO<sub>2</sub>,” as required by the March 27, 2015, [Burdens of Proof Order](#),<sup>49</sup> Minn. Rules Part 1400.7300, subp. 5, and *In re Quantification of Env'tl. Costs Pursuant to Laws of Minn. 1993, Chapter 356, Section 3*, 578 N.W.2d 794, 801 (Minn. Ct. App. 1998).

## **II. THE FEDERAL SOCIAL COST OF CARBON IS NOT “REASONABLE” AND IS NOT “THE BEST AVAILABLE MEASURE” TO DETERMINE THE ENVIRONMENTAL COST OF CO<sub>2</sub>**

### **A. Parties’ positions**

#### **1. The CEOs and the Agencies - FSCC**

The CEOs and the Agencies have introduced evidence in support of their proposition that the FSCC is reasonable and the best available measure to determine the environmental cost of CO<sub>2</sub>, offering the testimony of Dr. Stephen Polasky, Dr. John Abraham, Dr. Andrew Dessler, and Dr. Peter Reich (CEOs), and Dr. W. Michael Hanemann and Dr. Kevin Gurney (Agencies). The FSCC summary schedules provide (rounded)<sup>50</sup> FSCC values of \$12 at a 5% discount rate, \$43 at a 3% discount rate, \$65 at a

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<sup>49</sup> [Order Regarding Burdens of Proof dated March 27, 2015](#) at 2 and 6.

<sup>50</sup> The exact amounts provided by the models are set forth in Table 4 of Exhibit 2 to Dr. Smith’s direct testimony (Ex. [302](#) at 43) and Table 4A (Ex. [307](#)), and reflect values at a 3% discount rate of \$42.14 in 2007 dollars and \$46.88 in 2014 dollars, (continued)

2.5% discount rate, and \$125 at a 3% discount rate, 95th percentile, each for 2020 emissions per metric ton (in 2007 dollars).<sup>51</sup>

Even the proponents of the FSCC concede that there is an incredible amount of uncertainty involved with the federal model, admitting that “[t]here’s inherent uncertainty in predicting future damages,” (Tr. Vol. 1 at 114:16-17 (Polasky)), and that there is “a lot of uncertainty.” (Tr. Vol. 5 at 63:19-20 (Reich).) What the economy and personal preferences of society will look like in the year 2300 has “got great uncertainty about it.” (Tr. Vol. 1 at 172:13-17 (Polasky).) In fact, Dr. Polasky has admitted that the models cannot be tested; “this is an experiment ... so [the models are] [in] the category of projections.”<sup>52</sup>

## 2. Alternative positions

The Minnesota Large Industrial Group (MLIG); a group of utilities consisting of Great River Energy, Minnesota Power, and Otter Tail Power Company (the “Utility Group”); Xcel Energy; and Peabody Energy all respectfully disagree with the CEOs’ and the Agencies’ proposition, and have each offered alternative environmental cost values for CO<sub>2</sub>. The MLIG and the Utility Group shared a common witness, Dr. Anne E. Smith,

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both per metric ton, and values at a 5% discount rate of \$12.03 in 2007 dollars and \$13.39 in 2014 dollars.

<sup>51</sup> See Ex. [100](#) at Schedule 3 at p. 18 (App. A1).

<sup>52</sup> Tr. Vol. 1 at 81:6-12; 81:13-82:1; 82:24-83:6 (Polasky). See also Tr. Vol. 4 at 81:5-8 (Martin) (“regardless of the time horizon, there are serious challenges in estimating climate damages”) (referring to statements in EPRI Technical Assessment).

and are most closely aligned in their alternative values, which are between Xcel Energy's proposal and Peabody's proposal.

Xcel Energy's proposal is arrived at using the IWG's data, which data is then substantially slimmed down to approximately 38% of the data points considered by the IWG, after which various statistical methods are applied. Xcel suggests an environmental cost value ("ECV") of CO<sub>2</sub> range of 12.13 to \$41.40 per net short ton for emission year 2020 (in 2014 dollars).<sup>53</sup> This is equivalent respectively to \$13.37 to \$45.65 per net *metric* ton for emission year 2020 (in 2014 dollars),<sup>54</sup> which are respectively within 0.15% and 2.6% of the IWG's 5% and 3% FSCC discount values.<sup>55</sup>

The MLIG and the Utility Group retained Dr. Smith, who testified about a number of errors in and issues with the methods used by the IWG. Required to provide opinions based on a damage-cost approach basis,<sup>56</sup> Dr. Smith is the only witness in this proceeding who invested the time and energy to re-run the models multiple times, first under the original assumptions used by the IWG to verify that she was running them correctly, and then under four corrective key framing assumptions, to wit, time horizon (the years 2100 or 2140, rather than the year 2300); discount rates (3%, 5%, and 7%, rather than 2.5%, 3%, and 5%); marginal ton considered (first or average ton emitted, rather than last ton);

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<sup>53</sup> Tr. Vol. 4 at 15:16-23 (leakage) (Martin); *id.* at 121:11-19 (ECV) (Martin); Ex. [601, Martin Rebuttal](#) at 5:5-17 (ECV); *id.* at 51:5-53:25 (leakage-ECV to be applied to net tons).

<sup>54</sup> Tr. Vol. 4 at 122:2-12 (Martin).

<sup>55</sup> *Id.* at 121:1-125:18.

<sup>56</sup> See [Notice and Order for Hearing dated Oct. 15, 2014](#) at 4.

and geographic scope (U.S. rather than global).<sup>57</sup> Dr. Smith's proposed range for emissions in the year 2020 is \$1.62 to \$5.14 (in 2014 dollars per net metric ton).<sup>58</sup>

The MLIG further retained Dr. Ted Gayer, who testified regarding the geographic scope and advocated the use of a Minnesota, rather than a global, scope of damage calculation in the absence of express reciprocity, or at most a much smaller share of the damages scope, such as U.S. damages, if one were to consider demonstrative feelings of altruism even in the absence of reciprocity.

Dr. Gayer testified that the IWG "did provide some estimates of the national domestic benefits, but there was no effort to estimate the state-specific benefits of reducing CO<sub>2</sub>."<sup>59</sup> "For one set of national estimates, the IWG relied on one integrated assessment model (the FUND model) that permitted a U.S.-only analysis. This model suggests that the national SCC is about 7 to 10 percent of the global benefit. This would imply that using a global SCC measure where a national measure is appropriate results in an over-estimate of benefits of approximately 10- to 14-fold."<sup>60</sup> "Making this adjustment of the global SCC to domestic benefits (using the IWG's 2013 update) yields a SCC of \$0.77-\$1.10, \$2.24-\$3.20, \$3.57-\$5.10, and \$6.23-\$8.90 (2010 damage values in 2007

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<sup>57</sup> Ex. [300](#) (Smith Direct) at 29:13-22.

<sup>58</sup> The low value is based on modeling damages from the first ton emitted, 5 percent discount rate, U.S. damages, and a modeling horizon to year 2100. The high value is based on the average of first ton and last ton emitted, 3 percent discount rate, U.S. damages, and a modeling horizon to year 2140. (Tr. Vol. 2A at 60:17-63:3(Smith).)

<sup>59</sup> Ex. [400](#) (Gayer Direct) at App. 2 at 15.

<sup>60</sup> *Id.*



dollars).”<sup>61</sup>

Dr. Gayer showed that applying the IWG’s GDP-scaling approach results in extremely small damage estimates, considering that the estimate of the benefit to Minnesota is less than 0.4 percent of the estimated global benefit.<sup>62</sup> Even applying the GDP-scaling to the highest IWG FSCC estimate suggests a Minnesota-specific ECV of only about \$0.37 per metric ton of CO<sub>2</sub> (2010 damage value in 2007 dollars).<sup>63</sup>

Peabody’s experts arrived at a number of different estimates. Dr. Mendelsohn suggested that social cost of carbon values should range from \$4 to \$6 per metric ton at an equilibrium climate sensitivity (“ECS”) of approximately 3°C, \$0.30 to \$0.80 per metric ton at an ECS of 1.5°C, and \$1.10 to \$2.00 per metric ton at an ECS of 2°C.<sup>64</sup>

Dr. Tol testified that under the IWG’s parameters the FUND model as originally developed by him and as run by him estimated a social cost of carbon of \$8 per ton in 2011 and \$6.60 per ton in 2014, but arrived at negative social cost of carbon values (*i.e.*,

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<sup>61</sup> Ex. [400](#) (Gayer Direct) at App. 2 15-16 (respectively for damages calculated at a 5% discount rate, 3% discount rate, 2.5% discount rate, and 3% discount rate, 95th percentile). Dr. Gayer also testified that another IWG approach, which considered that the national social cost of carbon is about 23 percent of the global benefit, would yield FSCC values of \$2.53, \$7.36, \$11.73, and \$20.47 (2010 damage values in 2007 dollars, again for damages calculated respectively at a 5% discount rate, 3% discount rate, 2.5% discount rate, and 3% discount rate, 95th percentile). (*Id.* at 16.)

<sup>62</sup> Ex. [400](#) (Gayer Direct) at App. 2 at 16-17. Dr. Polasky agreed that Minnesota’s share of worldwide CO<sub>2</sub> production is only approximately 0.486%. (Tr. Vol. 1 at 183-191 (Polasky); Exs. [432](#) and [413](#).)

<sup>63</sup> Ex. [400](#) at App. 2 at 16-17.

<sup>64</sup> *See, e.g.*, Ex. [214](#) (Mendelsohn Direct) at 2.

carbon as a benefit) if the ECS is lower than 3°C.<sup>65</sup> Dr. Tol testified he did not know what the IWG changed to his model to arrive at the FSCC values calculated by the IWG using the FUND model.<sup>66</sup>

Dr. Bezdek stated that the Minnesota CO<sub>2</sub> values established in 1997 should be kept as they are, or reduced to about \$0.20 to \$2.00 per ton or lower.<sup>67</sup>

Based on the evidence and the testimony, the MLIG respectfully submits that the FSCC is not “reasonable” and is not “the best available measure to determine the environmental cost of CO<sub>2</sub>” because (i) there is a great amount of uncertainty built into the FSCC, which uncertainty is so excessive as to render the outcome of the models entirely speculative and unreliable; (ii) because the IWG’s data is out-of-date; (iii) because the IWG’s process was not peer-reviewed and contains erroneous assumptions; (iv) because the IWG did not follow applicable Office of Management and Budget policies; and (v) because the global geographic scope of the FSCC is not appropriate in the context of the setting of Minnesota environmental cost values in the absence of reciprocity by other U.S. states and by other nations, is not consistent with sound benefit-cost practices, and would demand a dramatic and untenable shift in all state policies if applied broadly.

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<sup>65</sup> See Ex. [238](#) (Tol Rebuttal report) at 4, 6-9.

<sup>66</sup> Ex. [238](#) (Tol Rebuttal report) at 6.

<sup>67</sup> Ex. [228](#) (Bezdek Direct) at 1-9, 26-28, 36; Ex. [232](#) (Bezdek Rebuttal) at Ex. 2 at 19, 22-23, 29, 38-39, 46-49, 87-88; Ex. [235](#) (Bezdek Surrebuttal) at 20-57, 66-71, 101-114.

**B. The IWG did not develop the FSCC for state resource planning, and the FSCC is not suitable for the purpose intended in Minnesota without—at a minimum—modifications**

As Mr. Martin has cogently testified, the FSCC was designed as a component of cost-benefit analysis of future Federal regulations, as part of the regulatory impact analysis required by the Office of Management and Budget under Executive Order 12866.<sup>68</sup> Dr. Smith noted that the IWG itself has noted the express purpose in estimating the FSCC is “to allow agencies to incorporate the social benefits of reducing carbon dioxide (CO<sub>2</sub>) emissions into cost-benefit analyses of regulatory actions that have small, or ‘marginal,’ impacts on cumulative global emissions.”<sup>69</sup> It is in this context important to note that the IWG intended the FSCC for use in federal regulation primarily affecting private consumption, rather than in the context of the expenditure of private capital.<sup>70</sup> Specifically, the IWG wrote in July 2015, that “[s]everal commenters indicated that a 7 percent discount rate is appropriate because it represents a better estimate of the opportunity cost of capital investments that would be displaced under compliance with a potential regulation to mitigate CO<sub>2</sub> emissions.”<sup>71</sup> However, according to the IWG,

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<sup>68</sup> Ex. [600, pt. 1](#) (Martin Direct) at 12:1-5.

<sup>69</sup> Ex. [302](#) (Smith Direct report) at 32 (*citing* February 2010 Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866 at 1 (copy attached as Schedule 2 to Ex. [100](#) (Polasky Direct))).

<sup>70</sup> Ex. [101, Ex. 1](#) (July 2015 *Response to Comments, Social Cost of Carbon for Regulatory Impact Analysis Under Executive order 12866* (Interagency Working Group on Social Cost of Carbon)) at 21-22.

<sup>71</sup> *Id.* at 21.

The 7 percent rate is an estimate of the average before-tax real rate of return to private capital in the U.S. economy. It is a broad measure that reflects the returns to real estate and small business and corporate capital and is meant to approximate the opportunity cost of capital in the United States. The 3 percent rate is an estimate of the real rate at which consumers discount future consumption flows to their present value, often referred to as the social rate of time preference or the consumption rate of interest.

The IWG examined the economics literature and concluded that the consumption rate of interest is the correct concept to use in evaluating the net social costs of a marginal change in CO<sub>2</sub> emissions, as the impacts of climate change are measured in consumption-equivalent units in the three IAMs used to estimate the SCC. This is consistent with OMB guidance in Circular A-4, which states that when a regulation is expected to primarily affect private consumption—for instance, via higher prices for goods and services—it is appropriate to use the consumption rate of interest to reflect how private individuals trade-off current and future consumption.<sup>72</sup>

This is an excellent example why the FSCC cannot be used in this proceeding without—at a minimum—modifications: the model designed by the IWG expressly includes a discount rate deemed appropriate to that analysis, but not appropriate to Minnesota resource planning and other resource-selection proceedings under Minn. Stat. § 216B.2422. Here, the initial investment decisions and resource choices are made exclusively by the utilities, which make (Commission-approved) capital investment choices. The Commission has as recently as May 8, 2015, approved Xcel’s capital structure and the rate of return at a weighted pre-tax cost of 7.35% for 2014 and 7.38%

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<sup>72</sup> Ex. [101, Ex. 1](#) at 21-22.

for 2015 in Xcel Energy’s Minnesota Electric Rate case, using a 9.72% cost of equity.<sup>73</sup>

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<sup>73</sup> See [May 8, 2015, Findings of Fact, Conclusions, and Order in Docket No. E-002/GR-13-868](#) at 61-62:

**XXVII. Capital Structure and Overall Cost of Capital**

The Company and the Department agreed on the Company’s capital structure for both the 2014 test year and the 2015 Step. The ICI Group initially argued that the equity component of the Company’s capital structure should be the same as the equity component of its parent company, Xcel Energy, Inc., but it did not ultimately include that claim among the modifications it recommended to the ALJ’s recommendations.<sup>68</sup>

The Company and the Department agreed on the cost of long- and short-term debt for both the 2014 test year and the 2015 Step; no other party commented. The Administrative Law Judge concurred in the Department and the Company’s joint recommendation on both capital structure and the cost of debt, as does the Commission.

The Company, the Department, the ICI Group, the Commercial Group, and AARP disagreed on the cost of common equity. As explained above, the Commission has set the cost of equity at 9.72%.

The resulting overall capital structure and cost of capital are set forth below, rounded to the second decimal place:

<b>2014 Test Year</b>			
<u>Component</u>	<u>Component Ratio</u>	<u>Cost</u>	<u>Weighted Cost</u>
Long-term Debt	45.6%	4.90%	2.23%
Short-term Debt	1.9%	0.62%	0.01%
Common Equity	<u>52.5%</u>	9.72%	<u>5.10%</u>
Total	100%		7.35%

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<sup>68</sup> ICI Exceptions at 41–42.

This is important to note, because these figures are used by Xcel as a discount rate in integrated resource planning. For example, in its most recent integrated resource plan dated January 2015, Xcel Energy assumed a before-tax weighted discount rate of 7.58% (after-tax discount rate of 6.62%) to determine the present value of revenue requirements:<sup>74</sup>

**C. Modeling Assumptions – Detail**

1. Capital Structure and Discount Rate

The rates shown in Table 1 were calculated by taking a weighted average of Minnesota (85 percent) and Wisconsin (15 percent) information from the January 2014 Corporate Assumptions Memo. The after tax weighted average cost of capital of 6.62 percent is used to calculate the capital revenue requirements of generic resources. It is also used as the discount rate to determine the present value of revenue requirements.

**Table 1: Capital Structure**

	Capital Structure	Allowed Return	Before tax	After tax
			Elec. WACC	Elec. WACC
L-T Debt	45.24%	5.12%	2.33%	1.37%
Common Equity	52.56%	9.89%	5.24%	5.24%
S-T Debt	2.20%	0.64%	0.01%	0.01%
<b>Total</b>			<b>7.58%</b>	<b>6.62%</b>

It would be entirely inconsistent for the State to approve a CO<sub>2</sub> environmental cost value  
(continued)

**2015 Step**

<u>Component</u>	<u>Component Ratio</u>	<u>Cost</u>	<u>Weighted Cost</u>
Long-term Debt	45.61%	4.94%	2.25%
Short-term Debt	1.89%	1.12%	0.02%
Common Equity	52.5%	9.72%	5.10%
Total	100%		7.38%

<sup>74</sup> Martin testimony, Tr. Vol. 4 at 94:1-95:17; Ex. [436](#) at 6.

that assumes a low discount rate for an extended investment horizon (150-200 years), which value would be used in resource planning where a higher discount rate is assumed over a shorter time horizon (15-30 years).

Next, approximately two-thirds of Minnesota's electricity consumption is by large industry and small, medium, and large companies. Only about one-third of Minnesota's electric consumption is by households.<sup>75</sup> While it may accordingly be appropriate to use lower private consumption rates of interest for the discount rate in an IWG model geared towards private consumption, that discount rate is not appropriate here. Because the IWG did not consider capital investments as part of its considerations, having expressly determined that the FSCC would be used for federal regulations primarily affecting private consumption,<sup>76</sup> it did not report its results at a 7% discount rate. Because the discount rate is arguably (one of) the most important driver(s) behind the FSCC,<sup>77</sup> the absence of that information should have been the end of the analysis, and the FSCC should have been rejected in its entirety. Fortunately, Dr. Smith has run the FUND, PAGE, and DICE models as the IWG did, and reported the model outcomes at a 7% discount rate. (*See, e.g.*, Ex. [307](#) (Table 4A) at line 7 (all assumptions identical to IWG

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<sup>75</sup> Tr. Vol. 4 at 89:4-14 (Martin).

<sup>76</sup> Ex. [101, Ex. 1](#) at 22.

<sup>77</sup> Tr. Vol. 4 at 82:8-10 (Martin) (“the discount rate observes [*sic*] more influence on the results than any other factor”); Ex. [302](#) (Smith Direct report) at 80 (“A very important framing question in the case of regulations that have benefits and/or costs that endure for a long period of time, as is the case with climate policy, is the choice of discount rate.”). *See also* Ex. [302](#) at 90, Table 14, demonstrating “the large effect that the discount rate has on the SCC values.” *See further* Ex. [100](#) at Schedule 2 (July 2010 IWG Technical Support Document) at 17.

but at fixed 7% discount rate); Ex. [302](#) (Smith Direct report) at 43 (Table 4) at line 7 (same).)

But the FSCC cannot be rescued merely by correcting the discount rate. The intended purpose of the FSCC is only to help identify, among the vast array of possible regulations to reduce greenhouse gas (“GHG”) emissions, those regulations that have positive net benefits. The FSCC was not designed to develop the content of the regulation or influence the choice of options to comply.<sup>78</sup> In contrast, if used in integrated resource planning and other Commission decisions in the Minnesota context, “the imprecise SCC would not [be called upon to] help determine *whether* to regulate, but rather *how* to make individual resource allocation decisions. These decisions – such as whether to operate or retire a power plant, what type of generation capacity to invest in, how to set solar tariffs, how to evaluate Conservation Improvement Program (CIP) benefits – are sometimes binary, difficult to reverse, and often have large and long-term implications for electricity rates, environmental impacts, and reliability.”<sup>79</sup>

Dr. Hanemann, testifying for the Agencies, argued for adoption of the FSCC notwithstanding this distinction, and commented that “[t]he IWG’s SCC estimates have also been used in analysis and discussions outside of the United States. For example, Canada used a social cost of carbon based on the IWG’s SCC in their regulatory impact

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<sup>78</sup> Ex. [600, pt. 1](#) (Martin Direct) at 12:22-13:11; Ex. [601, Martin Rebuttal](#) at 19-22; Ex. [602](#) (Martin Surrebuttal) at 7-9, 19-22.

<sup>79</sup> Ex. [600, pt. 1](#) (Martin Direct) at 13:13-20. *See also id.* at 13:22-14:9; Ex. [601, Martin Rebuttal](#) at 19:23-20:22:4; Ex. [302](#) (Smith Direct, Ex. 2) at 32, Para. 1.



analysis for the 2013 Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations” and “on April 22, 2014, Montgomery County, Maryland, revised its County Code 18A on environmental sustainability to require the SCC to be incorporated into return on investment for efficiency and sustainability decisions.”<sup>80</sup>

The MLIG respectfully submits that these two references are misleading, and that no other government has used the IWG’s FSCC for the purpose for which it is being proposed in this proceeding. Specifically, as Mr. Martin has testified, to the extent the Canadian government “copied” the IWG’s FSCC, “[t]his is an example of using the SCC precisely as intended – for cost-benefit analysis of federal regulations.”<sup>81</sup> Accordingly, Mr. Martin testified, and the MLIG agrees, the Canadian reference does not provide any rationale for using the IWG’s FSCC for Minnesota Public Utility Commission decisions.<sup>82</sup> Similarly, as to the Montgomery County, Maryland, Code, Mr. Martin testified that this regulation, like the federal FSCC, “also is more akin to deciding whether or not to regulate, than to making resource planning decisions.”<sup>83</sup>

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<sup>80</sup> Ex. [800, pt. 1](#) (Hanemann Direct) at 62:13-21.

<sup>81</sup> Ex. [601, Martin Rebuttal](#) at 20:12-21. It should further be noted that the automobile industries in the United States and Canada are integrated and that the alignment of the Canadian Regulations with the U.S. EPA standards was deemed important, so that the same U.S. EPA-estimated vehicle technology choices and adoption rates were used in the Canadian analysis. “This leads to the same proportional costs per vehicle, adjusted for exchange rates, as those that were used in the U.S. EPA analysis.” See <http://canadagazette.gc.ca/rp-pr/p2/2013/2013-03-13/html/sor-dors24-eng.html> (cited in Ex. [800, pt. 1](#) (Hanemann Direct) at 62, n.41) at section 7.5.1.

<sup>82</sup> Ex. [601, Martin Rebuttal](#) at 20:12-21.

<sup>83</sup> *Id.* at 20:1-21.

Second, no showing has been made that either government entity held a contested hearing or even that public comments were filed and considered. On the contrary, the Canadian announcement as cited by Dr. Hanemann suggests that no Board of Review was established.<sup>84</sup>

Dr. Hanemann has next suggested that the Commission should consider using the FSCC for integrated resource planning because four utilities have already done so.<sup>85</sup> As Mr. Martin has noted, Dr. Hanemann has provided no details about how the FSCC was used.<sup>86</sup> Instead, Dr. Hanemann's discussion abruptly shifts to the use of an "internal price of carbon for planning purposes," for which he cites a Carbon Disclosure Project (CDP) publication finding that 29 companies, including Xcel Energy, use such a price.<sup>87</sup>

[Dr. Hanemann] here confuses a regulatory cost proxy with a CO<sub>2</sub> damage cost value. The CDP report refers to Xcel Energy's use of a \$20 per ton carbon price (*sic*; actually \$21.50 per ton, the midpoint of the Commission's approved CO<sub>2</sub> regulatory cost range, as mandated under Minn. Stat. § 216H.06), as a way to account for the potential cost of future CO<sub>2</sub> regulations. However, as the Department of Commerce and Clean Energy Organizations themselves have noted, the regulatory cost range does not estimate damages and therefore cannot serve as the basis for a CO<sub>2</sub> externality value.<sup>88</sup> The Commission's regulatory cost range is derived

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<sup>84</sup> See <http://canadagazette.gc.ca/rp-pr/p2/2013/2013-03-13/html/sor-dors24-eng.html> (cited in Ex. [800, pt. 1](#) (Hanemann Direct) at 62, n.41) at first paragraph.

<sup>85</sup> Ex. [800, pt. 1](#) (Hanemann Direct) at 63.

<sup>86</sup> Ex. [601, Martin Rebuttal](#) at 20:23-21:12.

<sup>87</sup> Ex. [800, pt. 1](#) (Hanemann Direct) at 63.

<sup>88</sup> See for example the CEOs' "Memorandum in Support of Clean Energy Organizations' Motion to Update Externality Values for Use in Resource Decisions," *In the Matter of the Quantification of Environmental Costs* in Docket (continued)

from estimates of the cost of achieving compliance with future CO<sub>2</sub> regulations, and makes no attempt to estimate climate damages from CO<sub>2</sub> emissions.”<sup>89</sup> Neither the Canadian example, nor the Montgomery County example or the “utility integrated resource plan” example set forth on page 63 of Dr. Hanemann’s pre-filed direct testimony can accordingly support the application of the FSCC in the current context.

### C. The FSCC is out of date

The MLIG has not taken a significant position with respect to the science underlying the IWG’s FSCC. But one does not need to introduce testimony to conclude that the IWG’s FSCC is out of date with respect to the value of the equilibrium climate sensitivity. The importance of the ECS cannot be understated. With the discount rate, the ECS is a “very important driver” in the damages calculations made by the PAGE, DICE, and FUND models.<sup>90</sup>

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Nos. E999/CI-93-583. October 9, 2013, page 14, noting that “Pursuant to §216H.06, the Commission is required to apply projected likely carbon regulatory costs in resource acquisition proceedings. Regulatory costs are not the same as externalities and to compare them would be an apples-to-oranges comparison...” See also *Comments of the Minnesota Department of Commerce, Division of Energy Resources and the Minnesota Pollution Control Agency* in Docket No. E999/CI-00-1636. June 10, 2014, page 15 and 17, recommending the Commission require that any CO<sub>2</sub> externality values be damage values, not compliance costs, willingness-to-pay/accept, or other value types. The “internal price of carbon” cited by Dr. Hanemann from the CDP report is a proxy for regulatory compliance costs, not damage values.

<sup>89</sup> Ex. [601, Martin Rebuttal](#) at 20:23-21:12.

<sup>90</sup> Tr. Vol. 1 at 166:12-167:4 (Polasky).

The ECS is the amount of temperature increase caused by a doubling of CO<sub>2</sub>.<sup>91</sup> It is undisputed that the IWG did not use the climate sensitivity numbers provided by the models, and instead relied on its own estimates on climate sensitivity.<sup>92</sup> In doing so, the IWG did not rely on one fixed sensitivity, but applied a Roe and Baker distribution<sup>93</sup> (also at times cited as Baker-Roe) within a range of climate sensitivities contained in the IPCC’s November 2007 Fourth Assessment Report (“AR4”).<sup>94</sup> The IWG has acknowledged that “[s]ince that time, ... the IPCC issued a Fifth Assessment Report that updated its discussion of the likely range of climate sensitivity compared to AR4. The new assessment reduced the low end of the assessed likely range (high confidence) from 2°C to 1.5°C, but retained the high end of the range at 4.5°C. Unlike in AR4, the new assessment refrained from indicating a central estimate of ECS. This assessment is based on a comprehensive review of the scientific literature and reflects improved understanding, the extended temperature record for the atmosphere and oceans, and new estimates of radiative forcing.”<sup>95</sup> According to the IPCC’s 2013 Fifth Assessment Report, the new studies underlying the lowering of the low end of the ECS range “suggest a best fit to the observed surface and ocean warming for ECS values in the

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<sup>91</sup> Tr. Vol. 2A at 16:5-7 (Lindzen); Ex. 405 (IPCC’s 2013 Fifth Assessment Report) [part 36](#) at 1110.

<sup>92</sup> Tr. Vol. 1 at 97:18-21 (Polasky).

<sup>93</sup> Ex. [100](#) at Schedule 2 at 13-14 (IWG “selected Roe and Baker distribution”).

<sup>94</sup> See Ex. [101](#) at Schedule 1 (July 2015 IWG Response to Comments) at 12.

<sup>95</sup> Ex. [101](#) at Schedule 1 (July 2015 IWG Response to Comments) at 12. See also Ex. 405 (IPCC Fifth Assessment Report) [part 1](#) at 16 & n.16 and [part 36](#) at 1110-1111.

lower part of the *likely* range.”<sup>96</sup> To put this statement in context, Dr. Dessler, testifying for the CEOs, testified that “the ocean takes up heat. That’s where most of the heat trapped by greenhouse gases goes.”<sup>97</sup> According to Dr. Polasky, the AR4 ECS is outdated, and the “measure of central tendency” first and last found in AR4 has been abandoned.<sup>98</sup>

If, in fact, the “best fit to the observed surface and ocean warming for ECS values” suggest an ECS value in the lower part of the 1.5°C to 4.5°C range, as the IPCC wrote in 2013,<sup>99</sup> the impact on the ECV would be significant. Dr. Smith conducted a sensitivity study running the DICE 2010 model with the IMAGE socioeconomic scenario and a fixed ECS value of 1.5°C at discount rates of 3% and 5%. That study produced SCC estimates 57 percent to 60 percent lower than the IWG’s estimates,<sup>100</sup> as shown in Table 1 on page 15 of Exhibit [303](#) (Smith Rebuttal):

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<sup>96</sup> Ex. 405 [part 36](#) at 1111, first full paragraph (italics in original).

<sup>97</sup> Tr. Vol. 3B at 8:24-9:1 (Dessler).

<sup>98</sup> Tr. Vol. 1 at 165:10-15 (Polasky).

<sup>99</sup> Such an IPCC conclusion would be supported by the testimony of Drs. Spencer, Happer, and Lindzen. See Exs. [200](#), [202](#), [203](#), [204](#), [206](#), [207](#), [209](#), [210](#), [211](#), [213](#), [221](#), [223](#), [224](#), [225](#), and [227](#).

<sup>100</sup> Comparison is against the IMAGE scenario with the fixed ESC of 3. Comparison against the initial IWG assumptions, with the ECS Roe and Baker distribution would yield 60% and 65% reductions.

Table 1. Sensitivity of 2020 SCC Estimates Using DICE 2010 and the IMAGE Socioeconomic Scenario (\$/tonne CO<sub>2</sub>, 2007\$)

	3% discount rate	5% discount rate
No changes from IWG assumptions (i.e., replicating IWG’s result for IMAGE scenario)	\$48	\$15
Using fixed value of equilibrium climate sensitivity = 3 (i.e., median value of IWG’s probability distribution)	\$43	\$14
Using fixed value of equilibrium climate sensitivity = 1.5	\$17	\$6

(See Ex. [303](#) at 13:2-15:3.) For each row, Dr. Smith identified the specific changes she made from the IWG’s analysis using the DICE 2010 model and the IWG’s socioeconomic “IMAGE” scenario. These are SCC values for emissions in the year 2020, and are stated in 2007\$, which is the dollar-year used in the IWG’s reports.<sup>101</sup> Dr. Smith notes that the table shows that “only a small portion of this reduction is due to having used a fixed rather than probabilistic assumption on the parameter’s value.” *Id.* at 14:8-17.

Given Dr. Lindzen’s uncontroverted testimony that Roe and Baker distributions give special emphasis to high values<sup>102</sup> and given a potential 57% to 60% overstatement

<sup>101</sup> To convert to 2014\$, multiply the values by 1.11. (Ex. [303](#) (Smith Rebuttal) at 14:12-13.)

<sup>102</sup> Tr. Vol. 2A at 38:6-7 (Lindzen).

in damages values, straight adoption of the FSCC values for Minnesota PUC purposes would be arbitrary and capricious. In fact, the CEOs' Dr. Polasky agreed in this regard that "the evaluation that needs to be undertaken by the Commission in setting the environmental cost value should include a hard look at the framing assumptions that were used to generate the federal social cost of carbon," responding that "certainly one would want to think about important assumptions that went into a report before adopting, yes."<sup>103</sup>

The MLIG respectfully suggests based on the above that the ALJs and the Commission here should reject the IWG's FSCC as outdated. In 1997, the Commission rejected consideration of arguments supported by the U.S. Environmental Protection Agency's National Ambient Air Quality Standards ("NAAQS"), because "the EPA has not been able to keep the NAAQS updated," and that, accordingly, at that time the NAAQS did "not reflect the latest scientific knowledge." The Commission therefore concluded that it was "clear that the NAAQS *currently* are not necessarily set at no-cost levels."<sup>104</sup> Similarly, the IPCC has made it clear that the 2007 AR4 ECS values are outdated, and that improved understanding, the extended temperature record for the atmosphere and oceans, and new estimates of radiative forcing require a new evaluation. By the time this issue reaches the Commission, the updated AR5 values will already be three years old and the IWG has acknowledged the issue, but has not updated its

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<sup>103</sup> Tr. Vol. 1 at 115:16-24 (Polasky).

<sup>104</sup> See [Order Establishing Environmental Cost Values, MPUC Docket No. 93-583, dated Jan. 3, 1997](#) at 16-17 (emphasis added).

calculations. The Commission should, respectfully, not accept data that the issuing agency knows is out of date.<sup>105</sup>

**D. The IWG’s FSCC values are based on unreliable damage functions for temperature increases above 3°C**

The IWG calculated its FSCC values using a time horizon of the year 2300. Dr. Smith testified that this horizon is “really extraordinary,” that it is based on the IWG’s own extrapolations from EMF 22 scenarios that end in the year 2100,<sup>106</sup> and that the IWG has failed to account for future adaptive decisions.<sup>107</sup> Specifically, Dr. Smith testified

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<sup>105</sup> Dr. Dessler testified that in the years since issuance of AR5 “the scientific community has swung back towards the Fourth Assessment’s range,” (Tr. Vol. 3A at 18:1-4), and that continued reliance on the AR4 ECS is accordingly “reasonable.” (*Id.* at 18:13-17.) Not only was this evidence stricken from the record, (Tr. Vol 3A at 6-60:22), but Dr. Dessler had to acknowledge that he has not participated in the Fourth or Fifth Assessment; “there has been no statistically significant warming since the year 2000;” that “there has been a reduction in the rate of warming over the last 10 or 15 years;” “the trend includes the possibility of a zero change;” that “predicting the temperatures in the future[] is a much more uncertain exercise;” that he is not “an expert in ocean temperatures;” that he is “not familiar” with articles published in 2014 presenting observational evidence for deep ocean cooling since 2005; that there’s evidence for a differential between more infrared energy (heat) escaping from earth as a result of the Iris effect than sunlight coming in, resulting in up to a 0.5°C heat loss; and that he was not aware that evidence against an ECS above 4.5°C has gotten stronger since AR4. (Tr. Vol. 3A at 19:21-25; 20:14-20; 21:3-7; 26:17-20; 32:5-6; 32:11-15; 32:19-25:24; 52:14-16; 52:24-53:4.) Dr. Dessler further testified that uncertainty regarding the right value of the ECS has increased, (Tr. Vol. 3A at 49:6-16), and Dr. Dessler’s evidence for his statement that since issuance of AR5 “the scientific community has swung back towards the Fourth Assessment’s range” turned out to be based on hearsay, and was excluded. (*Id.* at 50:2-11.)

<sup>106</sup> Dr. Smith was the supervisor of modeling teams involved in EMF 22. Ex. [300](#) at 920-10:10.

<sup>107</sup> Tr. Vol. 2A at 56:10-15 (Smith); Ex. [300](#) at 22:7-20 (Smith).



that

A horizon of 2300 means the IWG is using the IAMs to make projections almost three hundred years into the future. Such far-future economic projections are inherently highly speculative, to the point where they are nearly worthless. Today, we have almost no idea what the global economy will look like in 2300, let alone what impacts specific changes in temperature will have on that economy -- just as those alive in 1715 would have found it nearly impossible to make accurate predictions regarding our economy and societal values today. Moreover, the IWG's 2300 model horizon assumes, unrealistically, that future generations will passively endure temperature changes as high as 10°C above pre-industrial levels, without taking any steps whatsoever to address the causes of such temperature changes.<sup>108</sup>

Dr. Smith pointed out that the IAMs' damage functions are based on a limited number of studies of the economic impact of warming of 3°C or less.<sup>109</sup> The IAMs, however, are used to predict the damage to the economy of much greater changes in temperature.<sup>110</sup> Lacking any foundational data for the greater range, the modelers have had to extrapolate the shape of a damages curve above 3°C without being able to validate the shape with empirical data.<sup>111</sup> Despite the absence of an empirical foundation, the higher damage levels at higher projected temperatures in the modeled damages curve

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<sup>108</sup> Ex. [300](#) (Smith Direct) at 22:7-20; *see also* Ex. [601, Martin Rebuttal](#) at 24:12-25:8.

<sup>109</sup> Ex. [300](#) at 18:17-19:2. Dr. Polasky agrees with Dr. Smith and with the IWG that "there is currently a limited amount of research linking climate impacts to economic damages." (Tr. Vol. 1 at 83:7-85:3 (Polasky); Ex. [100](#) at Schedule 2 (Feb. 2010 IWG Technical Support Document) at 5.)

<sup>110</sup> *Id.*

<sup>111</sup> *Id.*

elevate the IWG's SCC estimates.<sup>112</sup> Quoting Professor Pindyck, Dr. Smith stated that

[IAMs] can say nothing meaningful about the kinds of damages we should expect for temperature increases of 5°C or more. ....Thus we are left in the dark; IAMs cannot tell us anything useful about catastrophic outcomes, and thus cannot provide meaningful estimates of the SCC.<sup>113</sup>

In addition, according to Dr. Smith, the FSCC estimates are speculative because of the lack of specificity of the dose-response relationships that are implicit in the IAMs' extrapolations.<sup>114</sup> The current estimates of CO<sub>2</sub> environmental cost values for Minnesota were based on estimates of loss in GDP due to projected temperature changes through the year 2100, with an assumption that temperature will have increased 4°C above pre-industrial levels by that time.<sup>115</sup> "Mr. Ciborowski (the witness who prepared those estimates) relied upon projections that either ended by or before 2100, or addressed only temperature changes of 2.5°C or 3°C, which were being projected to occur well before 2100."<sup>116</sup> Dr. Smith pointed out that "[t]hese researchers' decisions to limit their analytic horizons (observed in both Mr. Ciborowski's references and also in the EMF 22 scenarios) are not because they fail to understand that damages from GHG emissions in the near term will last beyond 2100. Rather, modelers know that the uncertainty in any projections they can make expands as those projections go further in time, until at some

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<sup>112</sup> Ex. [300](#) (Smith Direct) at 18:17-19:2.

<sup>113</sup> Ex. [304](#) (Smith Surrebuttal) at 10:22-11:6 (citations omitted).

<sup>114</sup> Ex. [300](#) (Smith Direct) at 19:21-20:1.

<sup>115</sup> Ex. [302](#) (Smith Direct report) at 69.

<sup>116</sup> *Id.*

point the projections are not useful or meaningful. When the projections depend strongly on assumptions about technologies and/or consumer preferences, analysts feel that horizons much beyond 80 to 100 years is where uncertainty reaches that overly speculative point.”<sup>117</sup>

Dr. Smith testified in her pre-filed testimony that “Cline (1992) is the one source that Mr. Ciborowski relied on that considers the role of potential damages in the far future (2250), at much higher temperatures (10°C), and even he presented his calculations as a “conceptual” exercise. He concluded:

[P]erhaps the single most important need for research on greenhouse policy is to identify the prospective damages over the very-long-term, on the order of 250-300 years. The scientific community simply has not made these estimates... The furthest out the scientific community has yet been prepared to venture is to the year 2100.

In making this statement, Cline makes it clear that projections of damages beyond about 2100 are simply thought experiments that cannot be treated as credibly as the estimates for the period up through 2100.”<sup>118</sup> Dr. Smith has accordingly unambiguously expressed that the IWG’s values beyond the year 2100 are “driven more by the speculative portions of the IAMs’ damages functions than by the portions that have at least some evidentiary basis.”<sup>119</sup>

Both the CEOs’ witnesses and the Agencies’ witnesses agree that the damages are

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<sup>117</sup> Ex. [302](#) at 69.

<sup>118</sup> *Id.* at 69-70 (citations omitted).

<sup>119</sup> Ex. [300](#) at 23:2-5.

inherently uncertain, and become more and more uncertain as the time horizon is extended.<sup>120</sup> Dr. Polasky testified that there really isn't empirical data to support the estimation of damages above a 3°C degree increase in temperature from temperatures at pre-industrial times, and that we haven't even reached 2°C above pre-industrial (year 1900) levels.<sup>121</sup> Furthermore, Dr. Polasky testified that

Q. Okay. Now, is it realistic to predict what is going to happen 300 years into the future?

A As with all of these things, there's uncertainty. So the further you go out, yes, it's very uncertain. 300 years? It's uncertain 100 years.

Q. .... Is it actually realistic to think that somebody back in 1715 could predict what the temperature would be today and what the effect of the temperature would be on our current GDP?

A Certainly not with the science they had in 1715. But realistically, you know, the point is, yeah, the further out you go the more difficult it is. The greater the range of uncertainty, that is correct.<sup>122</sup>

Challenged about his basis for believing that the IWG “got it right,” Dr. Polasky testified that the IWG’s multi-agency process “drew on the expertise of many experts.”<sup>123</sup>

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<sup>120</sup> See, e.g., Tr. Vol. 1 at 114:16-17 (Polasky: “inherent uncertainty in predicting future damages”); Tr. Vol. 1 at 11:20-12:1; 81:6-12; 81:13-82:1; 82:24-83:6; 172:13-17 (Polasky); Tr. Vol. 5 at 63:19-20 (Reich).

<sup>121</sup> Tr. Vol. 1 at 124:7-13; 211:21-25 (Polasky).

<sup>122</sup> Tr. Vol. 1 at 89:22-90:11 (Polasky).

<sup>123</sup> Tr. Vol. 1 at 61:23-25 (Polasky).

But the testimony has shown that due to the “deliberative process privilege,”<sup>124</sup> with the exception of three people, the names and even the positions of individuals who worked on the FSCC are not known, nor is it known which individuals did which things in the IWG, or what their educational and professional work experiences/backgrounds were, rendering blind reliance unreasonable.<sup>125</sup>

What, then, Dr. Smith asked, is the period of time over which present damage functions can be considered to be supported by evidence? “One answer would be to look to the lifespan of technologies available or foreseeable today, and that can be reasonably anticipated to be installed when the extant but aging technologies are replaced. Even the longest-lived technologies, such as electricity generating plants, rarely remain economical to operate more than about 80 years; accounting for the period over which presently foreseeable technologies might be adopted could expand the reasonable horizon perhaps another 40 years.”<sup>126</sup> “This indicates that a modeling horizon for SCC estimates that do not contain undue speculative content regarding monetized damages would be about 2100 and no more than 2140. The reasonable horizon would be considerably less for projecting societal values in sectors that are served by less long-lived forms of

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<sup>124</sup> This privilege protects “documents reflecting advisory opinions, recommendations and deliberations comprising part of a process by which governmental decisions and policies are formulated.” *See Nat’l Labor Relations Bd. v. Sears, Roebuck & Co.*, 421 U.S. 132 (U.S. 1975).

<sup>125</sup> *See, e.g.*, Tr. Vol. 1 at 87:19-88:1; 112:9-16; 113:4-9; 152:18-153:1; 156:5-9 (Polasky).

<sup>126</sup> Ex. [302](#) (Smith Direct report) at 75.

capital.”<sup>127</sup> “Stated another way, the amount of speculation about societal risks and preferences using a 2100 horizon for SCC estimation would be similar to attempting to project societal values associated with today’s medical procedures, devices, drugs and immunizations, our communication methods such as the internet and smartphones, our range of food sources, our uses of electricity and gasoline, our methods of electricity generation, and our household appliances as an extension of the mix of services consumed and technologies available in 1935.”<sup>128</sup> “A 2140 horizon would be like attempting to estimate societal values for such services and capabilities from the vantage point of 1895’s demands and capabilities. The former would perhaps anticipate the relative importance of various types of services within a degree of recognition, but overstate each sector’s vulnerabilities. The latter would probably be far off base.”<sup>129</sup>

A recent study by the Electric Power Research Institute (EPRI, 2014) evaluates the reasonableness of these IWG projections in detail and concludes “As a group, the extensions lack a coherent, viable, and intuitive storyline (or set of storylines) that drive all of the extensions from 2100 to 2300.”<sup>130</sup> EPRI arrives at these conclusions for the following reasons:<sup>131</sup>

- The forecasts are not self-consistent. The IWG extrapolates land-use CO<sub>2</sub> emissions, non-CO<sub>2</sub> radiative

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<sup>127</sup> Ex. [302](#) (Smith Direct report) at 75.

<sup>128</sup> *Id.*

<sup>129</sup> *Id.*

<sup>130</sup> Ex. [302](#) (Smith Direct report) at 68 (citations omitted).

<sup>131</sup> *See* Ex. [302](#) (Smith Direct report) at 68-69.

forcing, population, GDP, and fossil and industrial CO<sub>2</sub> emissions. But these extrapolations are done in isolation without considering the effect of one forecast on all other forecasts. Therefore, the set of extensions lack internal consistency.<sup>132</sup>

- The forecasts are inconsistent regarding physical facts. EPRI finds all the IWG's extensions except the 5th Scenario result in an amount of CO<sub>2</sub> emissions that greatly exceed the CO<sub>2</sub> emissions that could come about from the combustion of all current estimates of global fossil fuel reserves. Current estimates of total CO<sub>2</sub> embodied in reserves of fossil fuel fall between 3,700 and 7,100 Gt CO<sub>2</sub>. All IWG scenarios except the 5th Scenario forecasts total cumulative emissions in excess of 8,100 Gt CO<sub>2</sub> in 2200 and above 10,900 Gt CO<sub>2</sub> by 2300. The MERGE scenario's cumulative 2300 emissions exceed the emissions from reserves by 4.5 to 8.5 times. None of these relationships invalidate the IWG scenarios because new technologies could be developed or resources found that would greatly increase the level of reserves, but this would likely mean a significant increase in fossil fuel prices. However, none of the IWG extensions consider the feedback that the high demand for fossil fuels could have on the prices of fossil fuels. EPRI notes this relationship between current reserves and the amount of fossil energy that the IWG's extensions imply will be needed "further illustrates the need to consider socioeconomic structure and its uncertainty in the development of socioeconomic and emissions assumptions."
- There is a lack of diversity among the forecasts. The possible ways in which the world will evolve over the next three hundred years is much greater than five. But in

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Population growth rate declines linearly, reaching zero in the year 2200. GDP/per capita growth rate declines linearly, reaching zero in the year 2300. The decline in the fossil and industrial carbon intensity (CO<sub>2</sub>/GDP) growth rate over 2090-2100 is maintained from 2100 through 2300. Net land use CO<sub>2</sub> emissions decline linearly, reaching zero in the year 2200; and non-CO<sub>2</sub> radiative forcing remains constant after 2100. (Ex. [302](#) (Smith Direct report) at 68 (citations omitted).)

some ways, the five scenarios represent only two regulatory outcomes. The four EMF scenarios represent a [business-as-usual] situation where no action is taken to reduce GHG emissions, and the 5th scenario represents a scenario in which the world strives to be on a 550 ppm CO<sub>2</sub> concentration.

· Furthermore, the formulas to project the post 2100 forecasts for population, GDP per capita, carbon intensity, net land use CO<sub>2</sub> emissions, and non-CO<sub>2</sub> radiative forcing are the same for all scenarios. Therefore, the IWG fails to consider a broad range of ways in which the market could evolve as required in the OMB's guidelines for regulatory analysis.<sup>133</sup>

The MLIG respectfully submits that the record shows, by more than a preponderance of the evidence, that the IWG's FSCC values lack any empirical basis for temperature increases above 3°C, and are based on unreliable damage functions beyond a horizon of the year 2100 or (at most) 2140. In turn, this means that the CEOs' and the Agencies' suggestion and recommendation that the ALJs and the Commission accept the IWG's FSCC, without adjustments, as Minnesota's ECV of CO<sub>2</sub> must be rejected.

#### **E. The IWG used an incorrect marginal ton**

The IWG's FSCC values are calculated assuming that the emitted ton of CO<sub>2</sub> being valued would be the last ton to be added to the global CO<sub>2</sub> emissions inventory, which overstates the marginal damage. Dr. Smith testified that it is inappropriate to assume that a particular ton of CO<sub>2</sub> emitted in the near future would be the last ton to be decided on as part of a 300-year "business as usual" baseline of otherwise unconstrained

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<sup>133</sup> Ex. [302](#) (Smith Direct report) at 68-69 (citations omitted).



future emissions,<sup>134</sup> since many of the tons emitted that contribute to the FSCC will not be emitted until much later than the Minnesota tons in question and by others than Minnesota, while the carbon emitted in Minnesota is no more or less harmful than carbon emitted elsewhere and is also no more or less harmful than any of the tons assumed to be emitted in the future.<sup>135</sup> Dr. Smith testified that, for example, the FSCC value for 2020 depends on the concentration of greenhouse gasses projected to already exist by 2020, all emissions produced in 2020, and all emissions produced from 2020 into the far future.<sup>136</sup> Dr. Smith further testified that in the case of greenhouse gases, the marginal damage estimate varies with the baseline projection of greenhouse gas emissions and is higher if it is calculated against a baseline reflecting a world in which no greenhouse gas control policies are in place, compared to a world that includes global greenhouse gas control policies.<sup>137</sup> Dr. Smith thus concluded that a more appropriate marginal value should be calculated using a projection of CO<sub>2</sub> and other greenhouse gas emissions consistent with the global target that is considered appropriate to address climate change concerns, which

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<sup>134</sup> For four of the five IWG scenarios, the baseline emissions projection reflects a business-as-usual world. Thus, each 2020 ton is valued against a future baseline projection in which no other reductions are ever made. However, if there is to be any actual climate benefit in reducing CO<sub>2</sub> emissions in Minnesota, those actions *have* to be part of a comprehensive policy. (Ex. [302](#) (Smith Direct report) at 53 (emphasis in original).) The “5<sup>th</sup> scenario” has a baseline that reflects global emissions being reduced to achieve atmospheric concentration stabilization at 550 ppm, but this scenario receives only 20% weight in the calculation of the IWG’s SCC values, as it is only one of five scenarios that are averaged together. (*Id.*)

<sup>135</sup> Ex. [300](#) at 20:7-21:1.

<sup>136</sup> Ex. [300](#) at 20:18-21.

<sup>137</sup> Ex. [300](#) at 21:16-21.

the IWG did not do.<sup>138</sup> Dr. Mendelsohn agrees with this critique, noting that the IWG calculated the SCC “assuming zero abatement not only today but forever. Not only in the United States but everywhere.”<sup>139</sup> In Dr. Mendelsohn’s words, “[t]he IWG made a conceptual error by measuring the wrong SCC.” Mr. Martin also agrees with Dr. Smith and testified that the IWG’s calculation of damages by using the “last ton” as the marginal use creates excessive damages, and that an “average ton” should be used instead of the “last ton.”<sup>140</sup>

#### **F. The IWG used an incorrect discount rate**

As set forth above, the IWG’s FSCC is based on an assumption that its regulation would be used solely for regulation expected to “primarily affect private consumption—for instance, via higher prices for goods and services,” which made it appropriate for the IWG to use “the consumption rate of interest to reflect how private individuals trade-off current and future consumption,”<sup>141</sup> but which simultaneously renders the IWG’s FSCC inappropriate to set Minnesota’s ECV of CO<sub>2</sub> for resource planning.

Separate and apart from this fundamental problem with adoption of the IWG’s FSCC for Minnesota electric-utility resource-planning, the IWG’s use of a 2.5% interest rate is problematic and raises the ECV of CO<sub>2</sub> inappropriately. The IWG has

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<sup>138</sup> Ex. [300](#) at 21:21-22:5.

<sup>139</sup> Ex. [214](#) (Mendelsohn Direct) at 15:21-16:2; Exhibit [216](#) (Mendelsohn Direct report) at 9, 10.

<sup>140</sup> Tr. Vol. 4 at 46:3-47:14.

<sup>141</sup> Ex. [101](#), Ex. 1 (July 2015 IWG Response to Comments) at 22.

acknowledged that

The choice of a discount rate, especially over long periods of time, raises highly contested and exceedingly difficult questions of science, economics, philosophy, and law. Although it is well understood that the discount rate has a large influence on the current value of future damages, there is no consensus about what rates to use in this [climate change] context.”<sup>142</sup>

As Dr. Smith has credibly and cogently testified, many of the values recommended in the literature and in this proceeding are driven more by moral philosophy than informed by empirical analysis.<sup>143</sup> Recommendations for the right discount rate can be categorized as either (1) descriptive of observed human behavior, consistent with market evidence that reveals human preferences, or (2) prescriptive or normative in nature, reflecting subjective moral judgments without evidentiary basis.<sup>144</sup> Dr. Smith testified that the use of a 2.5% rate is unsupported by empirical evidence, does not meet the criteria that Minnesota used in the prior proceeding, and noted that an element of the IWG’s decision to adopt this rate as one of three rates was to insert a subjective view and ethical considerations among some policy analysts that people living today should not discount the consumption of future generations in the manner which they discount their own within-generation consumption choices.<sup>145</sup>

Dr. Smith testified that the “prescriptive approach for setting lower-than-observed

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<sup>142</sup> Ex. [100](#) at Schedule 2 (July 2010 IWG Technical Support Document) at 17.

<sup>143</sup> Ex. [302](#) (Smith Direct report) at 80.

<sup>144</sup> *Id.*

<sup>145</sup> Ex. [302](#) (Smith Direct report) at 80-82; 87-89.

discount rates when conducting a [benefit cost analysis] for a policy that affects multiple generations often starts with an appeal to the ethical notion that it is inappropriate for present generations to give less weight to the consumption that entirely different generations will enjoy than we give to our own current generation's consumption."<sup>146</sup>

“The statement that the consumption (‘welfare’) of future generations should be given fair consideration when society makes decisions today that may have very long-term consequences is easy to accept. However, the prescription that the way to accomplish this is to use a discount rate that is lower than, and inconsistent with, empirical evidence of current societies’ consumption rate of interest is not the only approach that economists/philosophers have suggested for ethically accounting for future generations.”<sup>147</sup>

Dr. Smith pointed out that intergenerational welfare and growth models, as well as theories of intragenerational welfare, have been analyzed to assess economic criteria for intergenerational comparisons. Any number of possible intergenerational distributions can be derived from the models, but Prof. Mishan of the London School of Economics wrote that “no economic criterion can produce acceptable answers to the distribution problem – whether at a point of time or over time – since the problem is basically an

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<sup>146</sup> *Id.* at 87.

<sup>147</sup> *Id.* at 87-88.

ethical one.”<sup>148</sup> Recognizing the ethical issue is one of personal opinion, Prof. Mishan suggests he believes most people would agree on one premise with respect to intergenerational ethics:

For whatever be our view of the fundamental factors explaining differences in existing incomes, we are likely to agree that an equal per capita real consumption for all generations is an eminently fair arrangement ... In sum, the ethical appeal of equality of per capita consumption over generational time is independent of a belief in the justice of an equal division of the product in any existing society, and is far more compelling.<sup>149</sup>

This eloquent observation caused Dr. Smith to testify that “economic analysis offers no way to sort among prescriptive formulas. It is thus false to view the common prescription of adjusting the discount rate to lower levels than is descriptive of existing society’s consumption rate of time preference as the only ethical way to handle the question of fairness to future generations. In fact, studies have shown that the approach of addressing this concern through lowered discount rates creates analytic problems. Two such problems were noted by Farrow and Viscusi: time inconsistency and infinite benefits. Nordhaus (2007) further demonstrates that an overly low discount rate in an IAM model such as his DICE model results in nonsensical implications for savings rates.”<sup>150</sup>

Dr. Smith has further noted that while “prescriptive discounting adjustments are to

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<sup>148</sup> Ex. [302](#) (Smith Direct report) at 87 (*citing* Ezra J. Mishan, *Economic Criteria for Intergenerational Comparisons*, *Journal of Economics* 37(3-4):281-306 (1977) at 304).

<sup>149</sup> Mishan (1997) at 300-301.

<sup>150</sup> Ex. [302](#) (Smith Direct report) at 88 (citations omitted).

be avoided, the quote from Mishan suggests alternative ways to give consideration to the welfare of future generations. If he is correct that most would agree that we should manage existing societal decisions so that future generations will have at least our level of real consumption, then we can look to the IAMs’ projected consumption to determine how well different emissions regulations meet that objective.”<sup>151</sup>

Table 12 in [Dr. Smith’s report, Exhibit 302](#) (p.89) presents the real per capita consumption in each of the five IAM baseline scenarios in the current time (2020), and then in 2100, 2200, 2300. “These consumption paths are the endogenous ones that DICE calculates, given the climate impacts associated with each scenario’s respective projection of emissions.”<sup>152</sup> “In other words, the damage function in the model decreases the raw IWG projections of GDP in light of the emissions projected and their projected impact on temperature.”<sup>153</sup>

**Table 12. Real Undiscounted Consumption per Capita Over Time IAM Scenarios (Baseline Emissions)**

	IMAGE	MERGE	MESSAGE	MiniCAM	5th scenario
<i>Real global consumption per capita</i>					
2020	\$ 9,194	\$ 7,427	\$ 8,595	\$ 7,613	\$ 8,171
2100	\$ 37,133	\$ 22,892	\$ 26,912	\$ 36,671	\$ 31,106
2200	\$ 125,365	\$ 43,798	\$ 53,759	\$ 134,827	\$ 90,555
2300	\$ 169,660	\$ 49,239	\$ 63,872	\$ 187,494	\$ 122,001
<i>Consumption relative to 2020 consumption</i>					
2100 relative to 2020	4	3	3	5	4
2200 relative to 2020	14	6	6	18	11
2300 relative to 2020	18	7	7	25	15

Source: NERA runs of DICE model using median equilibrium climate sensitivity (ECS=3)

<sup>151</sup> Ex. [302](#) (Smith Direct report) at 88.

<sup>152</sup> *Id.*

<sup>153</sup> Ex. [302](#) (Smith Direct report) at 88 n.132. These calculations used the median value of the ECS (*i.e.*, 3°C). (*Id.*)

Table 12 shows that “even after absorbing the impacts of temperature change, all of the IAM scenarios are predicting that future generations will be far wealthier and have far higher consumption than is the case in the present. In fact, by 2100, they project that real consumption will be 3 to 5 times higher than we have today. By 2300, when the largest amount of climate impact (with unreduced business-as-usual emissions) will have occurred,<sup>154</sup> consumption will be between 7 and 25 times higher than we have today. Thus, the IAM scenarios that the IWG has used to compute the SCC of a ton of emission today are also implying that any cost we incur today will reduce our consumption in the present while adding to the vastly higher welfare of future generations.”<sup>155</sup> Given this significant increase in future generations’ consumption despite temperature change and the effects thereof and given the very significant factor by which the proponents of the FSCC seek to have resource-planning inputs increase to account for highly speculative damages over a very long time horizon, it is appropriate that the ALJs recommend to the Commission that it continue to act conservatively.<sup>156</sup> Contrary to feverish but unempirical pleas to preserve the welfare of future generations, the actual data in this

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<sup>154</sup> As stated above, for four of the five IWG scenarios, the baseline emissions projection reflects a business-as-usual world. (Ex. [302](#) (Smith Direct report) at 53.) The “5<sup>th</sup> scenario” has a baseline that reflects global emissions being reduced to achieve atmospheric concentration stabilization at 550 ppm, but this scenario receives only 20% weight in the calculation of the IWG’s SCC values, as it is only one of five scenarios that are averaged together. (*Id.*)

<sup>155</sup> Ex. [302](#) (Smith Direct report) at 88.

<sup>156</sup> Ex. [305](#) (March 22, 1996, Findings of Fact, Conclusions, Recommendation and Memorandum (ALJ Allan W. Klein), Docket 93-583) at Finding 36 (“The adopted values should be conservative.”)

proceeding shows that adoption of a reasonable and appropriate discount rate will not lead to the current generation taking advantage of such future generations, although, by definition, the current generation will be paying for the impacts of the values adopted as a result of this proceeding.<sup>157</sup>

Dr. Mendelsohn approaches the discount rate issue differently and testified that the use of the DICE2013 model's variable discount rate, which starts at 5% and is calculated to be consistent with the growth in GDP per capita, would be reasonably appropriate because it takes into account the interaction of GDP growth rates and discount rates.<sup>158</sup> Dr. Mendelsohn testified that the falling interest rate tied to slowing economic growth over time justifies a discount rate that falls over time, but does not justify a lower fixed rate.<sup>159</sup> Dr. Mendelsohn further testified that the 2.5% discount rate chosen by the IWG may be appropriate for the 23rd century, but not for today.<sup>160</sup>

**G. The IWG used a geographic scope that is not appropriate for Minnesota resource planning in the absence of reciprocity**

The IWG used a global scope for the calculation of damages resulting from the

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<sup>157</sup> The MLIG has expressed great concern for the impact on ratepayers in general, including household consumers of electricity, (Tr. Vol. 1 at 41:5-13), while Xcel, through Mr. Martin, has stated that “adoption of high CO<sub>2</sub> environmental cost values could result in increased energy costs, which could disproportionately affect lower-income rate payers, minorities, and the elderly.” (Ex. [601, Martin Rebuttal](#) at 35:18-22.)

<sup>158</sup> Ex. [214](#) (Mendelsohn Direct) at 12; Ex. [216](#) (Mendelsohn Direct report) at 16; Ex. [218](#) (Mendelsohn Rebuttal report) at 4:77-6:115.

<sup>159</sup> Ex. [218](#) (Mendelsohn Rebuttal report) at 6:111-115.

<sup>160</sup> Ex. [216](#) (Mendelsohn Direct report) at 16.



emission of CO<sub>2</sub> because damage is caused worldwide. The MLIG is aware that the Commission also currently uses a worldwide scope for the calculation of CO<sub>2</sub> damages. The MLIG respectfully submits, however, that a worldwide geographic scope is inappropriate in the absence of reciprocity; an issue that was not addressed in detail in the prior proceedings, and which it urges the ALJs and the Commission to review anew.

In 1997, the Commission considered that

Parties further objected that it would be “impracticable” for Minnesota to adopt CO<sub>2</sub> values because CO<sub>2</sub> (and any associated global warming) could not be addressed with any appreciable impact by Minnesota alone. It is true that CO<sub>2</sub> emissions in Minnesota (approximately 33 million tons per year) constitutes approximately 0.1 percent of global CO<sub>2</sub> emissions (approximately 60 billion tons per year). The objectors’ argument, however, does not really challenge the practicability (feasibility) of setting CO<sub>2</sub> values, but instead questions the wisdom of doing so in view of what they view as the inconsequential impact of such an effort. Their argument that nothing should be done because nothing “significant” (in the eyes of the objectors) can be done is a political argument not appropriately before the Commission. The legislature has made the appropriate political decision that the Commission should value CO<sub>2</sub> to the extent that this is feasible and, after rejecting some proposed ranges for CO<sub>2</sub> the Commission has done so.<sup>161</sup>

To be sure, Minnesota’s contribution to the world-wide CO<sub>2</sub> emissions is increasingly insignificant. It is unfathomable why the State and this Commission would want to increase the ECV of CO<sub>2</sub> and potentially jeopardize the State’s economy for no

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<sup>161</sup> [Order Establishing Environmental Cost Values](#) (January 3, 1997) at 26.

benefit.<sup>162</sup> Furthermore, the MLIG respectfully submits, that reciprocity plays a role in the quantity of the value to be assigned to the ECV of CO<sub>2</sub> and that the absence of reciprocity on both a national and international level means that a global geographic damages scope leads to an overstatement of damages.

Dr. Smith, Dr. Gayer, Mr. Martin, and Dr. Mendelsohn all agree that the value to be set should be impacted by reciprocity. In this regard, it is important to note that no witness suggests that reciprocal action would result from Minnesota's unilateral action.<sup>163</sup>

It is undisputed that CO<sub>2</sub> travels globally. In fact, it takes about one month for CO<sub>2</sub> to circulate around the Northern Hemisphere, such that if the CO<sub>2</sub> above Minnesota were to suddenly vanish, other CO<sub>2</sub> from the rest of the world would take its place in

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<sup>162</sup> *See, e.g.*, Tr. Vol. 4 at 100:21-23 (Martin) (other states and countries are likely to make CO<sub>2</sub> decisions on their own basis rather than in response to Minnesota's actions); Ex. [601, Martin Rebuttal](#) at 39 (Commission unable to negotiate explicit reciprocity); Tr. Vol. 3A at 99:2-24; 100:20-23 (Dessler) (China will not act in response to Minnesota's actions).

<sup>163</sup> *See, e.g.*, Tr. Vol. 4 at 100:21-23 (Martin) (other states and countries are likely to make CO<sub>2</sub> decisions on their own basis rather than in response to Minnesota's actions); Ex. [601, Martin Rebuttal](#) at 39 (Commission unable to negotiate explicit reciprocity); *id.* at 39-40 (Minnesota's adoption of a global SCC value – if it shifts resource planning decisions to reduce or even eliminate Minnesota's CO<sub>2</sub> is likely to lead to emissions leakage in an interconnected electricity system which would further diminish any effect. Meanwhile, because Minnesota has already made significant investments to reduce GHGs, a high SCC could lead to relatively high-cost further actions compared to mitigation options available elsewhere. This means the benefit (reduction in climate damages experienced by Minnesotans) would be small to negligible, while Minnesota utility customers could bear greater direct costs than they would under a resource plan that used a U.S. or Minnesota SCC value); Tr. Vol. 1 at 179:2-7 (Polasky) (does not “really know” whether concept of taxing or regulating to provide a benefit to persons outside the taxing or regulating jurisdiction is highly unusual); Tr. Vol. 3A at 99:2-24; 100:20-23 (Dessler) (no knowledge; China will not act in response to Minnesota's actions).

about a one-month period.<sup>164</sup> Accordingly, and as the IWG has noted, addressing global GHG emissions in a meaningful way requires all major emitting nations to reduce their emissions significantly, not just the U.S. emitters.<sup>165</sup> Importantly, this fact “leads to exactly the *opposite* conclusion about inclusion of global benefits in the SCC value from what the IWG concluded.” (Ex. [302](#) (Smith Direct report) at 96 (citations omitted; emphasis in original).) The reason is that IAMs “compute a high \$/ton value for a ton of U.S. emission not because the U.S.’s emissions are *causing* such high damages, but rather the SCC estimate is driven upwards by the effect of all of the other nations’ uncontrolled CO<sub>2</sub> emissions.”<sup>166</sup> Otherwise stated, if no other nation emitted GHGs, then the SCC estimate would be entirely due to U.S. emissions; however, that SCC estimate would be lower than what the IWG has computed.”<sup>167</sup> Thus, in the absence of other nations’ CO<sub>2</sub> emissions, it would be entirely appropriate to employ a global geographic damages scope. But given those other nations’ emissions and in the absence of reciprocity, it is inappropriate for Minnesota to do so.<sup>168</sup> Imposing the higher SCC estimate made by the IWG on U.S. entities pushes U.S. entities to make an unfairly large amount of emissions reductions, but without global benefit given the small portion of Minnesota’s contribution

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<sup>164</sup> Tr. Vol. 4 at 151:20-152:3 (Gurney).

<sup>165</sup> Ex. [302](#) (Smith Direct report) at 95-96.

<sup>166</sup> Ex. [302](#) (Smith Direct report) at 95-96 (emphasis in original).

<sup>167</sup> *Id.* at 96 (citations omitted).

<sup>168</sup> *Id.*

to global emissions.<sup>169</sup> Alternatively, if other countries imposed a SCC value on their own emissions equivalent to the SCC value the U.S. imposes, then their emissions would be lowered too, which would lower the global SCC.

As stated above, this analysis does not suggest that Minnesota should not compute and ECV for CO<sub>2</sub>. However, the value should be computed with a local geographic scope. Doing so is standard part of a benefit-cost analysis, which sums the benefits across people within the political jurisdiction whose citizens are choosing to undertake a policy and thereby be the ones to bear its costs.<sup>170</sup> This is consistent with defining “economic standing” based on legal rights. Both Dr. Smith and Dr. Gayer have testified that because Minnesota’s environmental cost values policy imposes potential costs on generators in Minnesota and near Minnesota, and the costs from such actions will then be passed to electricity customers residing only within Minnesota, economic standing should only be assigned to Minnesotans.<sup>171</sup> Dr. Gayer testified that since Minnesotans will accrue all costs, absent explicit reciprocity, it would be outside of the typical practice of benefit-cost analysis for Minnesota to consider the environmental benefits to the entire global population.<sup>172</sup> Dr. Gayer noted that there are countless examples of other policies

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<sup>169</sup> Ex. [302](#) (Smith Direct report) at 96. The Commission recognized Minnesota’s small contribution in 1997. [Order Establishing Environmental Cost Values](#) (January 3, 1997) at 26 (at the time approximately 0.1 percent of global CO<sub>2</sub> emissions).

<sup>170</sup> Ex. [302](#) (Smith Direct report) at 95 (citations omitted).

<sup>171</sup> Ex. [302](#) (Smith Direct report) at 95 (citations omitted); Ex. [400](#) (Gayer Direct) at 9.

<sup>172</sup> Ex. [400](#) at 9; Ex. [401](#) at 3:2-4:21.

(welfare, public education, tax, national defense) where the benefits and costs are considered for the jurisdiction enacting the program (*e.g.*, “the society”), not the global population. He believed that demonstrative feelings of altruism could justify considering some benefits outside of Minnesota, but adopting a global measure of benefits would go far outside appropriate and proportional proximity considerations. If applied broadly, such a policy would demand a dramatic shift in all state policies, including state poverty programs.<sup>173</sup> Similarly, it would suggest that a policy that incurs costs that leads to the relocation of people or businesses from Minnesota to other states or countries should not be considered a cost of the policy, and in all likelihood (depending on which state or country the activity is shifted to) should be considered a benefit of the policy. Demonstrative feelings of altruism could justify considering benefits outside of Minnesota, but any reasonable estimate of the magnitude of altruism would suggest only partial consideration of non-Minnesotans, with greater weight given in proportion to proximity. Even considering altruistic motivations, a national estimate would still likely over-estimate the benefits to Minnesotans of reducing CO<sub>2</sub>.<sup>174</sup>

Dr. Gayer testified that in the absence of even national reciprocity, the IWG’s estimates should be adjusted to the State level. Doing so would result in estimates that are approximately 0.4 percent of the global value in magnitude, suggesting extremely

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<sup>173</sup> If people across the world are given equal economic standing as Minnesotans, then state transfers motivated by helping the poor should shift away from helping low-income Minnesotans and towards transfers to much more impoverished non-U.S. citizens.

<sup>174</sup> Ex. [400](#) (Gayer Direct) at 9.

small damage estimates, with a high-end estimate of \$0.37 per metric ton of CO<sub>2</sub> (2010 damage value in 2007 dollars), as set out in detail in his report (Ex. [400](#), Appendix 2). Lacking a modeling component inherent in the IAMs that will calculate Minnesota-only damages, Dr. Smith recommended calculating only U.S. damages, and made this alternative framing assumption in her modeling. Although this change still significantly overstates Minnesota-specific damages, Dr. Smith argued it is more appropriate than using global damages and provides 100 percent altruistic weight to all other U.S. states.<sup>175</sup>

The MLIG respectfully submits that the above testimony, data, and analysis shows that the global geographic scope for damages calculations leads to an improper overstatement of damages in the absence of reciprocity, and urges the ALJs and the Commission to adopt a Minnesota-based scope of damages or, at most, a U.S. based scope of damages, which would provide 100 percent altruistic weight to all other U.S. states. As national or global reciprocity changes, this aspect of the damages calculation can be revisited, with increasing percentages of weight attributed to global damage as the rest of the world adopts CO<sub>2</sub> restrictions, which restrictions will reduce the global damages calculations, thus appropriately balancing out the increased weight attributed to global damages.

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<sup>175</sup> Ex. [302](#) at 99; Tr. Vol. 2A at 62:20-63:2. Dr. Smith also provided U.S. and non-U.S. components to her calculated values, so that the Commission can determine whether and to what extent it wants to give weight to non-U.S. damages in the environmental cost values to reflect altruism of Minnesotans.

#### **H. The use of the IWG's 95<sup>th</sup> percentile FSCC value over-weights uncertain risks relative to more certain risks**

The IWG has published four sets of values, calculated at discount rates of 2.5%, 3%, 5%, and the 95<sup>th</sup> percentile values at a 3% discount rate.<sup>176</sup> Various authors, including Dr. Polasky, advocate for the use of the 95<sup>th</sup> percentile FSCC value as an “insurance policy.” Dr. Polasky testified that the FSCC and home insurance, “both involve uncertainty about what damages might occur in the future. If we could be certain there would be no damages to our house over the next year, the value of home insurance would be zero. But the value of insurance is greater than zero because there is some, perhaps small, probability that a damage-causing event will happen (e.g., severe storm, fire). Suppose that there is a 5 percent chance of such an event occurring. That means there is a 95 percent chance that no such event will occur. In other words, 95 times out of 100, the possible future cost of damage to our home is \$0.00. Five times out of 100, however, the cost of those damages could be quite large. If we calculate the median of expected damages over the coming year, it is zero.”<sup>177</sup>

As Dr. Gayer explains in his surrebuttal testimony, the use of the IWG's 95th percentile FSCC value over-weights uncertain risks relative to more certain risks, and confuses “uncertainty” with “risk.”<sup>178</sup> Dr. Gayer explains that the mistake made is

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<sup>176</sup> See Ex. [100](#) at Schedule 3 at Table A1 (p.18).

<sup>177</sup> Ex. [101](#) (Polasky Rebuttal) at 38.

<sup>178</sup> Ex. [401](#) (Gayer Surrebuttal) at 14.

classical, and is known as the Ellsberg Paradox.<sup>179</sup> Risk is the probability of an event occurring; uncertainty is the degree of imprecision in the estimate of risk.<sup>180</sup> For example, consider two new automobiles. One poses a well-known defect risk of 2 in 1,000 over the lifetime of the vehicle. The other is newer to the market, and there is a 50-50 chance that the defect risk is either 1 in 1,000 or 3 in 1,000. Both of these automobiles have the same average risk (2 in 1,000), but the latter has greater uncertainty about the risk.<sup>181</sup> In this example the vehicles should be equally insured against defect risk, since they both have the same average risk (2 in 1,000).<sup>182</sup> However, the Ellsberg Paradox has demonstrated that people mistakenly exhibit a form of ambiguity aversion that makes the precisely known risk of the first automobile less fearsome than the uncertain risk of the second automobile.<sup>183</sup>

Ambiguity aversion is a form of irrational behavior and should not be confused with risk aversion in which people are averse to the risk of incurring a large loss. People might quite rationally choose to purchase a homeowners insurance policy for \$1,000 even though the expected losses are only \$800, but losses could be significant. Dr. Gayer

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<sup>179</sup> The Ellsberg Paradox is a paradox in decision theory in which people's choices violate the postulates of subjective expected utility in that they demonstrate a preference for taking on risk in which they know the specific odds rather than an alternative risk in which the odds are completely ambiguous. It is generally taken to be evidence for ambiguity aversion. (Ex. [401](#) (Gayer Surrebuttal) at 15 n.3.)

<sup>180</sup> Ex. [401](#) (Gayer Surrebuttal) at 14:18-19.

<sup>181</sup> Ex. [401](#) (Gayer Surrebuttal) at 14:19-15:1.

<sup>182</sup> *Id.* at 15.

<sup>183</sup> *Id.*



accordingly testified that a very low probability of a catastrophic loss would make such insurance attractive to a risk-averse person and could be quite rational. What would not be rational is to be swayed by the uncertainty regarding the risk probability.<sup>184</sup>

Similarly, the use of the 95<sup>th</sup> percentile value of a risk estimate (as Dr. Polasky is suggesting) is a mistake.<sup>185</sup> Doing so over-weights uncertain risks relative to more certain risks and distorts our policies and regulations in harmful ways. This may be illustrated by another hypothetical example, where there is enough money to clean up one hazardous waste site and one must decide between two sites. Site A contains a chemical contaminate that is well studied by researchers and presents a cancer risk of 1.25 in a million, known with certainty. Site B presents a relatively less researched contaminant that has an estimated cancer risk of 1 in a million, but there's a 50 percent chance of no risk and a 50 percent chance of a risk of 2 in a million. Site A presents a higher average risk (25 percent higher than the risk at Site B), so the resources should be devoted to cleaning it up before Site B, since doing so will prevent more cancer cases. But if one puts undue weight on uncertainty, as Dr. Polasky and the IWG did, then the resources will be devoted to cleaning up the more uncertain Site B, which decision, on average, would result in *more* expected cancer cases because of the higher average risk of cancer by not cleaning up Site A.<sup>186</sup>

Dr. Hanemann uses an example similar to Dr. Polasky's example to support the

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<sup>184</sup> Ex. [401](#) (Gayer Surrebuttal) at 16.

<sup>185</sup> *Id.* at 15.

<sup>186</sup> Ex. [401](#) (Gayer Surrebuttal) at 16:10-17:2.

use of the 95th percentile: “We wouldn’t get on a plane if there was a 5% chance of the plane crashing, but we’re treating the climate with that same level of risk in a very offhand, complacent way.” (Ex. [801](#) (Hanemann Rebuttal) at 71.) Although Dr. Gayer agrees that we should not ignore climate risks, he noted that Dr. Hanemann, like Dr. Polasky and the IWG, confuses risk with uncertainty. Dr. Gayer testified that “[t]he correct analogy is to suppose that Plane 1 has a 5 percent chance of crashing and we know with certainty that the risk is 5 percent (*i.e.*, it will definitely crash 5 in 100 times). Suppose Plane 2 has an average risk of crashing of 4 percent, but there’s a 50 percent chance that its risk of crashing is really 0 percent and a 50 percent chance that its risk of crashing is really 8 percent. Plane 2 has a lower average risk, so the rational choice is to choose to fly on Plane 2 rather than Plane 1. Of course, the Ellsberg Paradox suggests that numerous people (including apparently Dr. Polasky and Dr. Haneman[n]) would choose to fly on Plane 1, not understanding the higher risk they are taking. By including the 95<sup>th</sup> percentile of the SCC distribution (and not including the 5<sup>th</sup> percentile), Dr. Hanemann is in effect putting more weight on regulating uncertain, lower average, risk over more certain, higher average, risk. A classic Ellsberg-Paradox analytical mistake.”<sup>187</sup>

The MLIG urges the ALJs and the Commission to carefully distinguish between risk and uncertainty; to not fall for the Ellsberg Paradox; and to reject reliance on the 95<sup>th</sup> percentile damages calculations.

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<sup>187</sup> Ex. [401](#) (Gayer Surrebuttal) at 17:14-18:5.

## **I. Conclusion**

In the face of well-recognized uncertainty, which uncertainty is enhanced in the extreme by a damages calculation through the year 2300; because the IWG did not develop the FSCC for state resource planning, and because the FSCC is not suitable for the intended purpose without—at a minimum—modifications; because the FSCC—based upon the IPCC’s Fourth Assessment Report—is out of date and overstates damages; because the IWG’s FSCC values are moreover based on unreliable damage functions for temperature increases above 3°C, which increased become ever-important beyond the year 2100 as a result of the convex damages curve, the MLIG respectfully submits that the ALJs should find that the FSCC is neither “reasonable” nor “the best available measure” to determine the environmental cost of CO<sub>2</sub> in the context of this proceeding and the intended use of the environmental cost value of CO<sub>2</sub>.

Moreover, the MLIG has shown that the IWG used an incorrect marginal ton in its damages calculations; that the IWG’s use of a 2.5% discount rate is erroneous; that the IWG used a geographic scope that is not appropriate for Minnesota resource planning in the absence of reciprocity; and that the use of the IWG’s 95<sup>th</sup> percentile FSCC value over-weights uncertain risks relative to more certain risks. The MLIG accordingly respectfully submits that the ALJs should find that the FSCC is neither “reasonable” nor “the best available measure” to determine the environmental cost of CO<sub>2</sub> in the context of this proceeding and the intended use of the environmental cost value of CO<sub>2</sub>, and that the ALJs recommend that the Commission not rely on the Interagency Working Group on Social Cost of Carbon’s FSCC for use in resource planning and other resource-selection

proceedings under Minn. Stat. § 216B.2422.

### **III. XCEL HAS NOT PROVIDED A VIABLE ALTERNATIVE TO THE IWG'S ENVIRONMENTAL COST VALUE FOR CO<sub>2</sub>**

Xcel Energy has proposed an unusual alternative to the IWG's FSCC. The Company acknowledged, through Mr. Martin, that "the Federal SCC was not designed for integrated resource planning or other Commission decisions, and is inherently and irreducibly uncertain."<sup>188</sup> Without any modifications to the underlying data, the Company selected a limited range, consisting of only approximately 38% of the data points considered by the IWG. In doing so, the Company weighed the outputs from IAM model runs using each of the three discount rates used by the IWG (2.5%, 3%, and 5%).<sup>189</sup>

Mr. Martin's analysis generally provides information about the very wide range of environmental cost values that lie beneath the three individual average SCC values that the IWG provides for each of the three discount rate assumptions that the IWG chose.<sup>190</sup> However, there is no foundation in statistical theory or decision theory, nor any objective principle, to support the way a narrower range from that very wide range is then chosen by Xcel and recommended for use in Minnesota.<sup>191</sup> Lacking such an objective principle, the same data could be used to identify narrower and lower SCC ranges that have the

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<sup>188</sup> Ex. [600, pt. 1](#) (Martin Direct) at 50:20-23.

<sup>189</sup> Tr. Vol. 4 at 111:13-113:4..

<sup>190</sup> Ex. [303](#) (Smith Rebuttal) at 3:7-10.

<sup>191</sup> *Id.* at 3:10-12.

same probability of being accurate as the range recommended in Mr. Martin’s testimony; and the same data could be used to identify wider and higher SCC ranges that have the same probability of being accurate.<sup>192</sup> For that reason, the suggested approach is inherently subjective.<sup>193</sup>

More problematically, Mr. Martin’s approach unquestioningly adopts every one of the IWG’s subjective framing decisions, despite his own criticism of those assumptions on pages 3:1-4:3, 4:22-7:4, and 11:5-14:9 of his pre-filed direct testimony (Ex. [600, pt. 1](#)), and then injects one more very strong -- but unstated -- subjective assumption of his own, which is that the discount rates of 2.5%, 3%, and 5% should be given equal probability of being the “correct” value.<sup>194</sup> As Dr. Smith testified, “[t]he IWG at least recognized that SCC estimates based on different discount rates should be reported separately, leaving SCC users the ability to decide for themselves which of the three discount rates to emphasize for their decision-making purposes.”<sup>195</sup> Any adjustment in any of the interest rates, or any adjustment in the weight to be accorded any of those rates, requires complete rejection of Xcel Energy’s numbers, because the Xcel Energy data does not break out the discount rates.<sup>196</sup>

Of even greater concern is that Xcel Energy’s proposal omits the most likely

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<sup>192</sup> Ex. [303](#) (Smith Rebuttal) at 3:12-16.

<sup>193</sup> *Id.* at 3:17.

<sup>194</sup> Ex. [303](#) (Smith Rebuttal) at 3:17-23.

<sup>195</sup> *Id.* at 3:23-4:3.

<sup>196</sup> *See, e.g.*, Ex. [303](#) (Smith Rebuttal) at 4:3-7; Ex. [600, pt. 1](#) (Martin Direct) at 67:13-17 (new modeling required for change in discount rates).

damages numbers. Figure 9 on page 65 of Mr. Martin’s Direct (Ex. [600, pt. 1](#)) shows a histogram of the 450,000 IWG values considered by Xcel for inclusion.<sup>197</sup> Figure 9 further shows that the most frequent damage number in the entire set of 450,000 values was approximately \$5 or \$6, as depicted by the histogram’s peak, which “was a little bit below our lower bound and a little bit above zero.”<sup>198</sup> A different way to say this is that Xcel’s recommendations are based on data that it knows exclude the most likely damages amount, which amount was below the lower bound of data considered by Xcel:

Q. So the \$5 to \$6, which was a kind of a guesstimate that you gave to Mr. Brown, [as] the tip of the histogram, that’s the kind of data that was excluded from Xcel’s study, right?

A. That’s right....<sup>199</sup>

The MLIG respectfully submits based on the above that Xcel’s alternative proposal, which excluded both 62% of the total data and the most likely damages lacks an appropriate foundation, and must be rejected.

Rejection of Xcel’s “alternative” does not meaningfully change the numbers presented to the Commission in this proceeding because for all intents and purposes Xcel is recommending adoption of the IWG’s FSCC range under 3% and 5% discount rate assumptions. The IWG’s FSCC range as produced by the PAGE, FUND, and DICE models and without rounding is \$13.39 to \$46.88 per *metric* ton (in 2014 dollars).<sup>200</sup>

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<sup>197</sup> Tr. Vol. 4 at 240:12-22.

<sup>198</sup> Tr. Vol. 4 at 241:10-21; *id.* at 243:4-22.

<sup>199</sup> *Id.* at 243:23-244:6.

<sup>200</sup> *Id.* at 123:24-3; *id.* at 123:7-11; Ex. [307](#) (Table 4A) at lines 1 and 4.

Xcel proposes a range of \$12.13 to \$41.40 per *short* ton.<sup>201</sup> Converted to metric tons, Xcel’s range is \$13.37 to \$45.64.<sup>202</sup> While, admittedly, Xcel Energy’s process was different from the IWG’s, Mr. Martin admitted that “the numbers for planning purposes are virtually identical” to the FSCC’s range under the 3% and 5% discount rates.<sup>203</sup>

In the absence of a model with an empirical (or any) foundation and given the fact that Xcel Energy’s proposal is both entirely dependent on IWG’s modeling — and thus for the most part not independently updatable — and for planning purposes arrives at “virtually identical” data as the IWG’s FSCC range under the 3% and 5% discount rates, the MLIG respectfully submits that the ALJs and the Commission should reject Xcel’s “alternative” model.

#### **IV. DR. SMITH HAS PROVIDED A PRACTICABLE ALTERNATIVE TO THE IWG’S ENVIRONMENTAL COST VALUE FOR CO<sub>2</sub> IF THE COMMISSION DECIDES TO RELY ON A DAMAGE COST APPROACH**

For the reasons set forth above, the MLIG respectfully submits that the IWG’s Federal Social Cost of Carbon is neither “reasonable” nor “the best available measure” to determine the environmental cost of CO<sub>2</sub> in the context of this proceeding and the intended use of the environmental cost value of CO<sub>2</sub>, and that it should accordingly not be relied upon for use in resource planning and other resource-selection proceedings

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<sup>201</sup> Tr. Vol. 4 at 121:10:22.

<sup>202</sup> *Id.* at 122:9-12 (note typographical errors in transcript at lines 10 and 11, which should read \$45.64 and \$13.37; *see also id.* at 122:3 for conversion factor between short and metric tons; *id.* at 124:4-20.

<sup>203</sup> Tr. Vol. 4 at 124:24-125:18. *See also id.* at 120:15-121:5 (ECV difference of \$1.25 per ton would not “make a big difference” for resource planning purposes).

under Minn. Stat. § 216B.2422.

Dr. Smith has testified that a traditional damage cost approach for climate change would first ascertain climatic changes from projected emissions, then estimate the physical impacts on a variety of resources and amenities due to the climatic changes, and finally estimate the societal (monetized) value of the physical changes in the resources/amenities.<sup>204</sup> As Dr. Smith explains in detail in her report, (Ex. [302](#)), the IAMs largely skip the detailed steps involved in determining how particular physical resources will be impacted by climatic changes, and predict change in societal (monetary) value directly from the climatic changes themselves.<sup>205</sup> Only portions of the IAMs' SCC damage estimates are based on specific resource impact projections.<sup>206</sup> This aggregation of the logical steps into a reduced form function is not necessarily inappropriate when the structure of the underlying relationships is well understood. However, in the case of the IAMs, the damage functions are based on limited data regarding damages resulting from small changes in temperature, and they make large extrapolations to much higher-than-observed temperature changes.<sup>207</sup> The lack of specificity of the dose-response relationships that are implicit in those extrapolations -- and the degree to which the IWG's SCC estimates are based on the extrapolated portions of the damage functions -- imbue the

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<sup>204</sup> Ex. [300](#) (Smith Direct) at 19:7-11.

<sup>205</sup> *Id.* at 19:11-15; Ex. [302](#) at 20-25.

<sup>206</sup> Ex. [300](#) (Smith Direct) at 19:15-16.

<sup>207</sup> *Id.* at 19:16-21.



IWG's estimates with a degree of speculation that is problematic.<sup>208</sup>

Dr. Smith has testified that “the sensitivity of the IAMs to unverified and non-scientific assumptions made by modelers, as well as by model users, throws into question the reasonableness of using any SCC value that the IAMs may produce. The SCC values lack reasonableness for national-level as well as state-level policy-making, and alternative valuation approaches to the IAM-based SCC calculation of marginal damages may provide a more reliable set of values for Minnesota.”<sup>209</sup> However, if the Commission nevertheless seeks to rely on the damage cost approach, then Dr. Smith has testified that a number of key framing assumptions must be modified to reach relatively more appropriate estimates of damage costs from IAMs than the IWG has produced.<sup>210</sup> Specifically, there are four assumptions affecting the environmental cost value and a fifth assumption affecting the tons to which such value is applied that must be modified:

1. The damages horizon must be reduced to the year 2100 or, at most, 2140, inasmuch as a horizon through the year 2300 produces SCC values that contain an unacceptable degree of speculative content.
2. The IWG's use of a 2.5% rate is unsupported by empirical evidence, while a 7% discount rate is called for by long-standing federal rules as set forth in OMG Circular A-4 (Exhibit [417](#)) when a regulation will affect private sector capital spending, such as is the case here, because 7% approximates

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<sup>208</sup> Ex. [300](#) (Smith Direct) at 19:21-20:5.

<sup>209</sup> Ex. [300](#) (Smith Direct) at 17:2-12.

<sup>210</sup> *Id.* at 17:12-16.

the opportunity cost of displaced private sector investment.

3. The marginal ECV should be based on either the first or the average ton of CO<sub>2</sub> emitted, rather than the last ton added to the global CO<sub>2</sub> emissions inventory, which overstates the marginal damage that Minnesota should consider for environmental cost values from its potential emissions reduction decisions in resource planning.
4. In the absence of reciprocity from other U.S. states and from other nations, the geographic scope should, as set forth above, be based on Minnesota damages or U.S. damages (if the Commission were to provide 100 percent altruistic weight to all other U.S. states).
5. Finally, the Commission should adopt these values on a net ton basis in order to account for leakage.

After making these alternations to the FSCC, Dr. Smith's proposed range for emissions in the year 2020 is \$1.62 to \$5.14 (in 2014 dollars per net metric ton). The low value is based on modeling damages from the first ton emitted, 5 percent discount rate, U.S. damages, and a modeling horizon to year 2100. The high value is based on the average of first ton and last ton emitted, 3 percent discount rate, U.S. damages, and a modeling horizon to year 2140. Dr. Smith's Table 4A (Ex. [307](#)) contains numerous variations on each of the first four framing assumptions. Additionally, Dr. Smith can re-run the models at the Commission's request or provide the models to the Commission to allow the Commission to run the models. Application of Minnesota-only damages reduces the amount to \$0.37 per net metric ton of CO<sub>2</sub> (2010 damage value in 2007 dollars), applying

the IWG’s GDP-scaling to the highest FSCC estimate.<sup>211</sup>

As stated in the introduction, the MLIG respectfully submits that if the Commission desires to protect important Minnesota values such as the affordability of energy, that it maintain the conservative approach to the environmental cost of carbon recommended by ALJ Klein and adopted in its January 3, 1997, [Order Establishing Environmental Cost Values](#). As applied, the MLIG respectfully submits that the ALJs and the Commission should adopt a range for the environmental cost value of CO<sub>2</sub> of \$0.37 to \$5.14 per net metric ton (in 2014 dollars).<sup>212</sup>

**A. Appropriate damages horizon — 2100 or at most 2140**

As set forth above, Dr. Smith has testified that the IWG’s values beyond the year 2100 are “driven more by the speculative portions of the IAMs’ damages functions than by the portions that have at least some evidentiary basis.”<sup>213</sup> Both the CEOs’ witnesses and the Agencies’ witnesses agree that the damages are inherently uncertain, and become more and more uncertain as the time horizon is extended.<sup>214</sup> Dr. Polasky acknowledged that there really isn’t empirical data to support the estimation of damages above a 3°C

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<sup>211</sup> Ex. [400](#) at App. 2 at 16-17.

<sup>212</sup> If, on the other hand, the Commission desires to afford 100 percent altruistic weight to all other U.S. States, the MLIG supports Dr. Smith’s proposed range for emissions in the year 2020 of \$1.62 to \$5.14 (in 2014 dollars per net metric ton).

<sup>213</sup> Ex. [300](#) at 23:2-5.

<sup>214</sup> *See, e.g.*, Tr. Vol. 1 at 114:16-17 (Polasky: “inherent uncertainty in predicting future damages”); Tr. Vol. 1 at 11:20-12:1; 81:6-12; 81:13-82:1; 82:24-83:6; 172:13-17 (Polasky); Tr. Vol. 5 at 63:19-20 (Reich).

degree increase in temperature from temperatures at pre-industrial times.<sup>215</sup> In fact, even the best available modeling effort attempting to develop realistic rather than idealized scenarios specific to the inherently long-run concern of climate policy (the EMF 22) chose to make projections through only 2100.<sup>216</sup> Dr. Smith has further explained that while the IWG has explained the types of events that are implied by its scenarios, the IWG's basis for assuming those particular events will occur is minimal.<sup>217</sup>

As set forth above, the EPRI study has shown that numerous projections upon which the IWG based its modeling assumptions cannot be supported by empirical evidence, including, for example, the fact that all the IWG's extensions except the 5th Scenario result in an amount of CO<sub>2</sub> emissions that greatly exceed the CO<sub>2</sub> emissions that could come about from the combustion of all current estimates of global fossil fuel reserves.<sup>218</sup> (*See supra* at 42-44.) As further set forth above, Dr. Smith answered the question what then is the period of time over which present damage functions can be considered to be supported by evidence, by considering that one can look to “the lifespan of technologies available or foreseeable today, and which can be reasonably anticipated to be installed when the extant but aging technologies are replaced. Even the longest-lived technologies, such as electricity generating plants, rarely remain economical to operate more than about 80 years; accounting for the period over which presently

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<sup>215</sup> Tr. Vol. 1 at 124:7-13; 211:21-25 (Polasky).

<sup>216</sup> Ex. [302](#) at 67.

<sup>217</sup> *Id.*

<sup>218</sup> *See* Ex. [302](#) at 68-69.

foreseeable technologies might be adopted could expand the reasonable horizon perhaps another 40 years.”<sup>219</sup> “This indicates that a modeling horizon for SCC estimates that do not contain undue speculative content regarding monetized damages would be about 2100 and no more than 2140.”<sup>220</sup> As Dr. Smith explains in her report (Ex. [302](#) at 75), this horizon is already aggressive.

Dr. Smith’s recommendation has been criticized by Dr. Hanemann, Dr. Polasky, and Mr. Martin. Dr. Hanemann and Dr. Polasky argue that curtailing the time horizon to end at 2100 assumes there are no damages after 2100. They argue that while damages after 2100 have uncertainty, they are nonetheless real and significant and need to be included in the estimation of the SCC. Whether that is true is irrelevant; the question is whether the recognition of those damages means that one continues to rely on modeling even when one knows that the answer provided by the models is entirely speculative, unreliable, and in all likelihood dead wrong.<sup>221</sup> “It is true that any forecast of future conditions involves some degree of speculation. However, the further one projects, the more speculative the exercise becomes.”<sup>222</sup> “The EMF 22 scenarios that the IWG relies on through 2100 are at least informed by knowledge about current technologies and technologies presently in development. The degree of speculation grows at an increasing pace after 2100 because even the longest-lived technology rarely remains economical to

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<sup>219</sup> Ex. [302](#) at 75.

<sup>220</sup> *Id.*

<sup>221</sup> *See* Ex. [304](#) at 20:4-6.

<sup>222</sup> Ex. [304](#) at 17.

operate more than about 80 years, and speculation becomes the dominant element of any forecast after about 2140, since even presently foreseeable new technologies will be reaching their obsolescence by then.”<sup>223</sup> “Furthermore, as technologies change, so too do lifestyles and hence economic value of climatic changes that might be projected in that future era.”<sup>224</sup> “Accordingly, any empirical basis which would support projections out until 2100 or 2140 vanishes after that time.”<sup>225</sup>

Mr. Martin agrees that the choice of modeling horizon can affect the degree of speculation in the resulting SCC estimates.<sup>226</sup> Mr. Martin further agrees that the Commission could decide a shorter modeling horizon is appropriate to reduce speculation and that Dr. Smith’s recommendation of a modeling horizon of the year 2100 or 2140 is consistent with eliminating portions of the estimates which are based on particularly unrealistic assumptions or have little empirical data.<sup>227</sup> Mr. Martin recognizes that forecasting population, GDP growth and emissions globally is difficult, and predictions vary widely across the five Stanford Energy Modeling Forum scenarios (IMAGE, MERGE Optimistic, MESSAGE, MiniCAM, and 550 ppm average) used by the IWG. For example, global population in the year 2300 ranges from 8 billion to 11 billion people, and global GDP from about \$750 trillion to \$2,200 trillion, across the five

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<sup>223</sup> Ex. [304](#) at 17.

<sup>224</sup> *Id.*

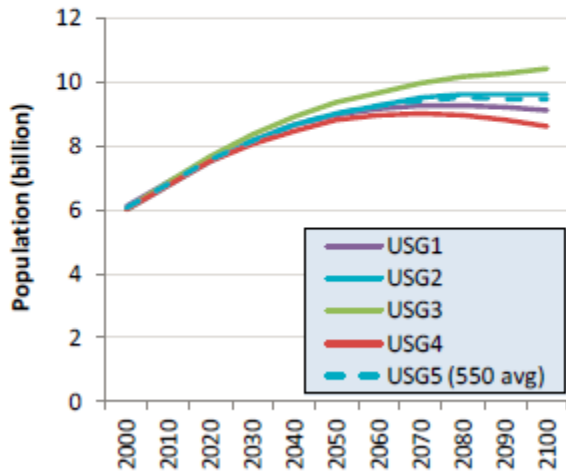
<sup>225</sup> *Id.*

<sup>226</sup> Ex. [601, Martin Rebuttal](#) at 43:20-44:14.

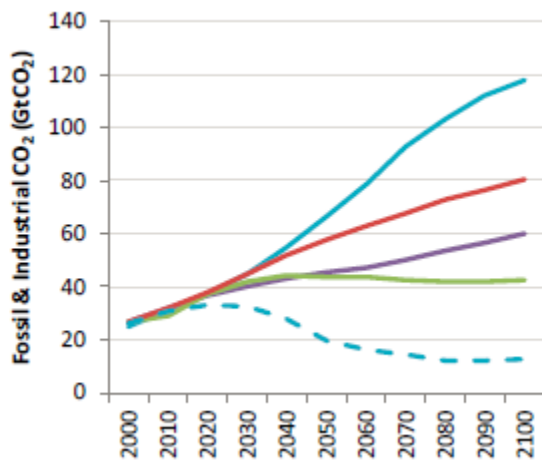
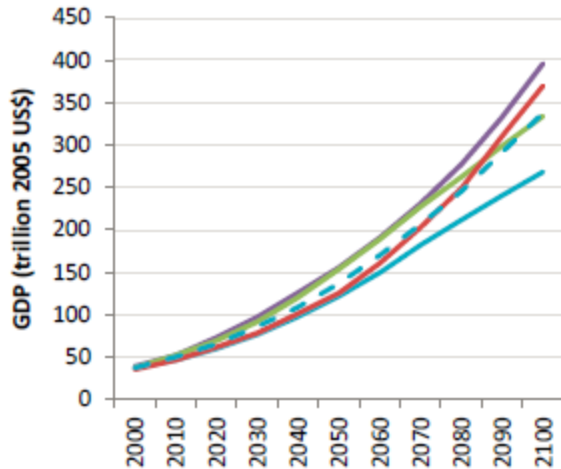
<sup>227</sup> *Id.* at 44:8-45:3.

scenarios, such that the “IWG’s assumptions about emissions based on the population and GDP are uncertain and speculative.”<sup>228</sup> Figure 5 on pages 32 and 33 of Mr. Martin’s Direct testimony (Ex. Ex. [600, pt. 1 Direct](#)) summarizes differences among the five scenarios and shows the variation in expected population, GDP and emissions results as follows:

**Figure 5**  
**Variation in Global Population, GDP, and Fossil and Industrial CO<sub>2</sub> Emissions to Year 2300 under IMAGE, MERGE Optimistic, MESSAGE, MINICAM, and 550 ppm Average (Here Labeled as USG1 to USG5 Respectively)<sup>28</sup>**



<sup>228</sup> Ex. [600, pt. 1 Direct](#) at 31; Tr. Vol. 4 at 76:13-16; *id.* at 77:7-9.



The only real concern Mr. Martin raises is his belief that the modeling horizon is a subjective policy judgment and the Xcel cannot provide a way within its modeling to incorporate a shorter horizon, because it is dependent on the original IWG data. This criticism does not overcome the abject lack of reliability inherent in a modeling horizon until the year 2300. In the absence of any empirical support for a longer modeling horizon and to avoid abject speculation, the MLIG accordingly seeks a finding that the longest appropriate modeling horizon supported by the evidence is the year 2100 or, at most, the year 2140.



**B. Appropriate discount rate — 5.66%**

Much has been written about the discount rate already, (*see supra* sections II.B, II.F, II.H and III), and those fact need not be repeated here. The IWG’s use of a 2.5% rate is unsupported by empirical evidence, while a 7% discount rate is called for by long-standing federal rules as set forth in OMG Circular A-4 (Exhibit [417](#)) when a regulation will affect private sector capital spending, such as is the case here, because 7% approximates the opportunity cost of displaced private sector investment. Accordingly, Dr. Smith testified that the discount rate to be used should have a lower bound of 3% and an upper bound of not less than 5%.<sup>229</sup>

The MLIG respectfully submits that it is appropriate to consider a discount rate of 5.66%, which consists of a usage-averaged discount rate based on the 3% consumption rate of interest identified by the IWG<sup>230</sup> (33.3%) and a conservative 7%<sup>231</sup> average before-tax real rate of return to private capital in the U.S. Economy (66.6%).<sup>232</sup> The relative weight is based on the fact that two-thirds of Minnesota’s electricity consumption is by large industry and small, medium, and large companies and only about one-third of

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<sup>229</sup> Ex. [300](#) (Smith Direct) at 24.

<sup>230</sup> *See* Ex. [102 \(Polasky Rebuttal\)](#) at Schedule 1 (July 2015 IWG Response to Comments) at 22.

<sup>231</sup> As set forth above, the Commission has as recently as May 8, 2015, approved Xcel’s capital structure and the rate of return at a weighted pre-tax cost of 7.35% for 2014 and 7.38% for 2015 in Xcel Energy’s Minnesota Electric Rate case, using a 9.72% cost of equity. (*See* [May 8, 2015, Findings of Fact, Conclusions, and Order in Docket No. E-002/GR-13-868](#) at 61-62.)

<sup>232</sup> *Id.* at 21.

Minnesota's electric consumption is by households.<sup>233</sup> Because this discount rate already includes a blend of "high" and "low" discount rates, the MLIG suggests that this one discount rate be used in calculating both the "high" and the "low" ends of the range of the environmental cost value of CO<sub>2</sub>, using the years 2100 and 2140 respectively as the "low" and the "high," together with a "first ton" ("low") and an "average ton" ("high") value.

**C. The ALJs should recommend the use of a first or average ton as the "marginal ton"**

As set forth above, it is inappropriate to use the "last ton" as the marginal ton, as the IWG has done, which overstates the marginal damage. (*See supra* at 5, 44-46.) Many of the tons emitted that contribute to the FSCC will not be emitted until much later than the Minnesota tons in question and by others than Minnesota, while the carbon emitted in Minnesota is no more or less harmful than carbon emitted elsewhere and is also no more or less harmful than any of the tons assumed to be emitted in the future.<sup>234</sup> Further, the marginal damage estimate varies with the baseline projection of greenhouse gas emissions and is higher if it is calculated against a baseline reflecting a world in which no greenhouse gas control policies are in place, compared to a world that includes global greenhouse gas control policies.<sup>235</sup> Dr. Smith thus concluded that a more appropriate marginal value should be calculated using a projection of CO<sub>2</sub> and other

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<sup>233</sup> Tr. Vol. 4 at 89:4-14 (Martin).

<sup>234</sup> Ex. [300](#) at 20:7-21:1.

<sup>235</sup> Ex. [300](#) at 21:16-21.

greenhouse gas emissions consistent with the global target that is considered appropriate to address climate change concerns, which the IWG did not do.<sup>236</sup>

As noted above, Dr. Mendelsohn agrees with this critique, testifying that the IWG calculated the SCC “assuming zero abatement not only today but forever. Not only in the United States but everywhere.”<sup>237</sup> In Dr. Mendelsohn’s words, “[t]he IWG made a conceptual error by measuring the wrong SCC.”

Mr. Martin also agrees with Dr. Smith and testified that the IWG’s calculation of damages by using the “last ton” as the marginal use creates excessive damages, and that an “average ton” should be used instead of the “last ton.”<sup>238</sup>

To understand the sensitivity of the estimated SCC value to the question of which emissions levels should be the point at which the marginal damages should be computed, Dr. Smith considered that the marginal benefit is if the Minnesota tons in question are viewed as the first increment to all future anthropogenic tons, rather than the last increment to a business-as-usual baseline.<sup>239</sup> To estimate the marginal value of the first ton, which is the lowest possible marginal value that the IWG’s IAMs will produce, Dr. Smith modified the IAMs so that the baseline scenario represents no anthropogenic

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<sup>236</sup> Ex. [300](#) at 21:21-22:5.

<sup>237</sup> Ex. [214](#) (Mendelsohn Direct) at 15:21-16:2; Exhibit [216](#) (Mendelsohn Direct report) at 9, 10.

<sup>238</sup> Tr. Vol. 4 at 46:3-47:14.

<sup>239</sup> Ex. [302](#) at 62.

emissions occurring after 2020.<sup>240</sup> She explained that this was merely an analytical device that allows one to infer the range of variation in the marginal damage estimate when using alternative future emissions projections.<sup>241</sup> The first ton analysis creates a lower bound for the Minnesota CO<sub>2</sub> environmental cost value and informs the Commission about how much of the IWG’s marginal value estimate is due to emissions yet to be emitted, and not due to historical and present GHG emissions.<sup>242</sup> The first ton analysis also allowed Dr. Smith to calculate a rough approximation of the average marginal value by averaging first and last ton estimates.<sup>243</sup>

Dr. Smith’s “first ton calculation” has been criticized by a number of witnesses, who claim that Dr. Smith seeks to pretend there are no emissions after 2020, which obviously is not a realistic prediction of future emissions.<sup>244</sup> Mr. Martin agrees with Dr. Smith that the IWG’s calculation of damages by using the “last ton” as the marginal use creates excessive damages, and that an average ton should be used,<sup>245</sup> but does not know how to calculate an “average ton.”<sup>246</sup> Dr. Hanemann, the Agencies’ witness, testified that “Dr. Smith’s suggested first ton analysis is unexceptional for a flow pollutant [such as

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<sup>240</sup> Ex. [302](#) at 62.

<sup>241</sup> Ex. [304](#) at 22:8-23:4.

<sup>242</sup> Ex. [304](#) at 22:15-17.

<sup>243</sup> Ex. [304](#) at 22:20-23:4.

<sup>244</sup> *See, e.g.,*

<sup>245</sup> Tr. Vol. 4 at 46:3-47:14.

<sup>246</sup> Tr. Vol. 4 at 48:21-49:6 (Martin).

criteria pollutants]. It is unreasonable with a stock pollutant, it is a category error.”<sup>247</sup>

In her surrebuttal, Dr. Smith addressed such criticism. She testified that

Dr. Hanemann is wrong, and it is surprising that he does not recognize what I did as a standard analytical method for backing out a marginal benefit curve from a complex bottom-up damage function model such as an IAM.<sup>248</sup> *The emissions projection I used to estimate the marginal damage of the “first ton” was never intended to be an accurate projection of total actual future outcome, but only to understand the sensitivity (i.e., range of variation) of the SCC estimate to different levels of projected future emissions. That analytical device allows me to inform the Commission on how much of the IWG’s SCC estimates are due to emissions yet to be emitted, as opposed to due to historical GHG emissions. Knowing that degree of sensitivity of the IAMs’ SCC values is essential to understanding how much the marginal damage will vary when using alternative (realistic) future emissions projections other than just those five projections that the IWG used. For example, knowing the sensitivity allowed me to estimate the SCC value associated with a baseline that has a very large amount of global emissions control effort, as contrasted to the IWG scenarios that assume no incremental regulation of GHGs for the next 285 years (which I called the “last ton” approach). By knowing this sensitivity, it is also possible to make a rough approximation of the average cost per ton, which I explained in my testimony could be an appropriate estimate under a perspective that the Minnesota environmental cost values are intended to represent an estimate of compensatory damages rather than externality pricing.*<sup>249</sup>

Dr. Smith further testified that damages from emissions that Minnesota chooses to avoid or eliminate in an effort to show leadership in responding to climate change should

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<sup>247</sup> Tr. Vol. 2B at 33:15-18 (Hanemann).

<sup>248</sup> In live testimony, Dr. Haneman, as set forth above, acknowledged that the analytical concept is valid. (See Tr. Vol. 2B at 33:15-17.)

<sup>249</sup> Ex. [304](#) (Smith Rebuttal) at 22:8-23:4 (emphasis added). See also *id.* at 22:1-6.

be valued in a range between treating them as if they were the first incremental anthropogenic greenhouse gas ton to be emitted (going forward in time) and treating them as the marginal ton evaluated against a baseline reflecting a very large cumulative emissions reduction relative to the business-as-usual forecasts.<sup>250</sup> To approximate these damages assuming use of IAMs, the upper bound should be set as the average of the marginal damage estimates for the first and last ton in the IWG projections.<sup>251</sup>

**D. The ALJs should recommend, and the Commission should adopt, a Minnesota-based scope of damages or, at most, a U.S. based scope of damages, which would provide 100 percent altruistic weight to all other U.S. states**

Like the discount rate, the geographic scope of damages has been discussed at length above. (*See supra* at 52-58.) Dr. Gayer cogently explained why in the absence of even national reciprocity, the IWG's estimates should be adjusted to state level. Doing so would result in estimates that are approximately 0.4 percent of the global value in magnitude, suggesting extremely small damage estimates, with a high-end estimate of \$0.37 per metric ton of CO<sub>2</sub> (2010 damage value in 2007 dollars), as set out in detail in his report (Ex. [400](#), Appendix 2).

Lacking a modeling component inherent in the IAMs that will calculate Minnesota-only damages, Dr. Smith recommended calculating only U.S. damages, and made this alternative framing assumption in her modeling. Although this change still significantly overstates Minnesota-specific damages, Dr. Smith argued it is more

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<sup>250</sup> Ex. [302](#) at 64.

<sup>251</sup> *Id.*

appropriate than using global damages and provides 100 percent altruistic weight to all other U.S. states.<sup>252</sup>

As above, the MLIG here respectfully submits that the testimony, data, and analysis shows that the global geographic scope for damages calculations leads to an improper overstatement of damages in the absence of reciprocity, and urges the ALJs and the Commission to adopt a Minnesota-based scope of damages or, at most, a U.S. based scope of damages, which would provide 100 percent altruistic weight to all other U.S. states. As national or global reciprocity changes, this aspect of the damages calculation can be revisited, with increasing percentages of weight attributed to global damage as the rest of the world adopts CO<sub>2</sub> restrictions, which restrictions will reduce the global damages calculations, thus appropriately balancing out the increased weight attributed to global damages.

**E. The ALJs and the Commission should account for potential leakage**

Technically speaking, leakage is not an issue in this proceeding, in that the amount of the ECV of CO<sub>2</sub> is not affected by leakage. However, both the IWG and multiple witnesses in this proceeding recognize the important impact leakage can have.

As Dr. Smith testified on September 25, 2015, “the IAMs assume that the ton that’s reduced, when they produce a dollar per ton, are assuming that ton really does disappear from the global atmosphere. But in using a social cost of carbon value that

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<sup>252</sup> Ex. [302](#) at 99; Tr. Vol. 2A at 62:20-63:2. Dr. Smith also provided U.S. and non-U.S. components to her calculated values, so that the Commission can determine whether and to what extent it wants to give weight to non-U.S. damages in the environmental cost values to reflect altruism of Minnesotans.

comes from one of these models, Minnesota might reduce its emissions by 100 tons and North Dakota might increase its emissions by selling electricity into Minnesota, perhaps by 100 tons, perhaps by 110 tons, perhaps by 50 tons, depending on what kind of leakage occurs. So you didn't get the 100-ton reduction in that case in Minnesota, you got perhaps 50 percent of it. So the net ton is only 50 tons in Minnesota. And the benefit -- the sort of environmental benefit that should come from an ECV calculation should be the dollar per ton estimate times that net ton, and not by the tons reduced in the project being evaluated. So it's reflecting leakage and the fact that leakage needs to be accounted for and specified as important in the application of any dollar per ton that comes from this process. So the net ton, is what I'm saying, apply it to the net tons after accounting for leakage, which hasn't been calculated at all here. But to the extent there's a lot of leakage, the implicit, the equivalent dollar per ton -- dollar per ton, gross ton, reduced in the Minnesota project will be much less. It could be zero if there's absolute leakage."<sup>253</sup>

Dr. Smith further explained that as the ECV of CO<sub>2</sub> increases, the likelihood that leakage or the problem of leakage is going to be, especially if one is acting in a leadership mode and the surrounding parties, like an electricity system in the surrounding states that are interconnected, don't take on any dollar per ton or take a lower one on.<sup>254</sup> In its extreme, leakage can, in fact, lead to a net increase in CO<sub>2</sub>, thus doing more harm than

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<sup>253</sup> Tr. Vol. 2A at 102:9-103:13 (Smith).

<sup>254</sup> *Id.* at 103:14-23.



good.<sup>255</sup>

In its July 2015 Response to Comments, the IWG stated that leakage “is an important issue for analysts to consider in determining the net CO<sub>2</sub> reductions to be valued in an RIA.”<sup>256</sup> The IWG accordingly instructed that “[t]he SCC estimates are multiplied by estimates of the net GHG emissions changes to calculate the value of benefits associated with a policy action in a given year. It is in the estimation of net GHG emissions, and not the SCC, that any leakage should be accounted for.”<sup>257</sup>

In light of the importance of the issue of leakage, and to ensure that the appropriate tons are considered for application of the ECV value of CO<sub>2</sub> to be set with the benefit of this proceeding, the MLIG accordingly respectfully asks that the ALJs express their ultimate findings and conclusions in dollars per (short or metric) *net* ton. This direction can then be used in resource planning proceedings.

## **F. Conclusion**

The MLIG has identified four key framing assumptions which must, at a minimum, be modified to arrive at a reasonably reliable environmental cost value of CO<sub>2</sub>. Each of these factors is an important element to ensure that the environmental cost value of CO<sub>2</sub> for application in the Minnesota context is reasonably accurate, rather than a wild

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<sup>255</sup> *Id.* at 103:24-104:1; Ex. [401](#) (Gayer Surrebuttal) at 9:7-10:3.

<sup>256</sup> Ex. [101](#) at 33.

<sup>257</sup> Ex. [101](#) at 33.

guess, without empirical basis.<sup>258</sup> Dr. Smith’s Table 4A (Ex. [307](#)), setting forth those framing assumptions and their conclusions, is reproduced as the last page of this Brief.

## CONCLUSION

From the start of this proceeding, the MLIG has been moved by great concern about the impact on electricity rates of the requested adoption of the federal government’s Interagency Working Group’s federal social cost of carbon (“FSCC” or generically “SCC”) for use in Minnesota resource planning and other resource-selection proceedings under Minn. Stat. § 216B.2422.

The MLIG has addressed the two questions posed by the Commission, answering why the FSCC is not reasonable nor the best available measure of the ECV for CO<sub>2</sub> and has provided alternative framing-assumption adjustments to the damages horizon, an alternative discount rate (5.66%), the correct marginal ton (the first and average tons), the correct geographic scope (Minnesota damages or, at most, U.S. damages if the Commission were to provide 100% altruistic weight to all other U.S. states), and has shown why the ALJs and the Commission should express the ECV of CO<sub>2</sub> in net tons to account for leakage.

The MLIG respectfully submits that if the Commission desires to protect important Minnesota values such as the affordability of energy, that it maintain the conservative approach to the environmental cost of carbon recommended by ALJ Klein

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<sup>258</sup> *See, e.g.*, Tr. Vol. 4 at 74:12-75:1 (Martin) (contrary to the federal context, if the Commission assumes an incorrect value in the context of Minn. Stat. § 216B.2422, “the allocation of resources would not be optimal.”)

and adopted in the Commission's January 3, 1997, [Order Establishing Environmental Cost Values](#). As applied, the MLIG respectfully submits that the ALJs and the Commission should adopt a range for the environmental cost value of CO<sub>2</sub> of \$0.37 to \$5.14 per net metric ton (in 2014 dollars).<sup>259</sup>

Respectfully submitted,

**STOEL RIVES LLP**

Dated: November 24, 2015

*s/ Marc A. Al*

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<sup>259</sup> If, on the other hand, the Commission desires to afford 100 percent altruistic weight to all other U.S. States, the MLIG supports Dr. Smith's proposed range for emissions in the year 2020 of \$1.62 to \$5.14 (in 2014 dollars per net metric ton).

**TABLE 4A**

**Summary of SCC Estimates for Alternative Values, Including Average Ton.<sup>1</sup>**

	# changes from base inputs	Discount Rate	Time Horizon	Geographic Scope	Which Tonne	2020 SCC Value (2007\$/net tonne)	2020 SCC Value (2014\$/net tonne)
1.	0	3%	2300	Global	Last	\$42.14	\$46.88
2.	1	3%	2140	Global	Last	\$32.53	\$36.19
3.	1	3%	2100	Global	Last	\$22.14	\$24.63
4.	1	5%	2300	Global	Last	\$12.03	\$13.39
5.	2	5%	2140	Global	Last	\$10.70	\$11.90
6.	2	5%	2100	Global	Last	\$9.03	\$10.05
7.	1	7%	2300	Global	Last	\$4.84	\$5.38
8.	2	7%	2100	Global	Last	\$4.26	\$4.74
9.	1	3%	2300	U.S.	Last	\$6.88	\$7.65
10.	2	3%	2140	U.S.	Last	\$5.36	\$5.96
11.	2	3%	2100	U.S.	Last	\$3.97	\$4.42
12.	2	5%	2300	U.S.	Last	\$2.28	\$2.54
13.	3	5%	2140	U.S.	Last	\$1.99	\$2.22
14.	3	5%	2100	U.S.	Last	\$1.77	\$1.97
15.	2	7%	2300	U.S.	Last	\$1.03	\$1.15
16.	3	7%	2100	U.S.	Last	\$0.92	\$1.03
17.	1	3%	2300	Global	First	\$27.59	\$30.70
18.	2	3%	2140	Global	First	\$21.55	\$23.98
19.	2	3%	2100	Global	First	\$15.55	\$17.30
20.	2	5%	2300	Global	First	\$8.43	\$9.38
21.	3	5%	2140	Global	First	\$7.65	\$8.51
22.	3	5%	2100	Global	First	\$6.70	\$7.45
23.	2	7%	2300	Global	First	\$3.65	\$4.06
24.	3	7%	2100	Global	First	\$3.33	\$3.70
25.	2	3%	2300	U.S.	First	\$4.83	\$5.37
26.	3	3%	2140	U.S.	First	\$3.88	\$4.32
27.	3	3%	2100	U.S.	First	\$3.05	\$3.40
28.	3	5%	2300	U.S.	First	\$1.76	\$1.96
29.	4	5%	2140	U.S.	First	\$1.59	\$1.77
30.	4	5%	2100	U.S.	First	\$1.46	\$1.62
31.	3	7%	2300	U.S.	First	\$0.87	\$0.96
32.	4	7%	2100	U.S.	First	\$0.81	\$0.90

<sup>1</sup> The Average Ton figures in Table 4A are derived by taking the average of the first and last ton figures for a given discount rate, geographic scope, and time horizon set forth in Table 4 in the Expert Report of Anne Smith. For example, the average ton for a 3% discount rate, 2300 time horizon, and global scope in Line 33 is derived by taking the averages of the first (line 17) and last ton (line 1) for the same discount rate, time horizon, and global scope.

(Cont'd)

	# changes from base inputs	Discount Rate	Time Horizon	Geographic Scope	Which Tonne	2020 SCC Value (2007\$ /net tonne)	2020 SCC Value (2014\$ /net tonne)
33.	1	3%	2300	Global	Average	\$34.87	\$38.79
34.	2	3%	2140	Global	Average	\$27.04	\$30.09
35.	2	3%	2100	Global	Average	\$18.85	\$20.97
36.	2	5%	2300	Global	Average	\$10.23	\$11.39
37.	3	5%	2140	Global	Average	\$9.18	\$10.21
38.	3	5%	2100	Global	Average	\$7.87	\$8.75
39.	2	7%	2300	Global	Average	\$4.25	\$4.72
40.	3	7%	2100	Global	Average	\$3.80	\$4.22
41.	2	3%	2300	U.S.	Average	\$5.86	\$6.51
42.	3	3%	2140	U.S.	Average	\$4.62	\$5.14
43.	3	3%	2100	U.S.	Average	\$3.51	\$3.91
44.	3	5%	2300	U.S.	Average	\$2.02	\$2.25
45.	4	5%	2140	U.S.	Average	\$1.79	\$1.99
46.	4	5%	2100	U.S.	Average	\$1.62	\$1.80
47.	3	7%	2300	U.S.	Average	\$0.95	\$1.06
48.	4	7%	2100	U.S.	Average	\$0.87	\$0.97

**CERTIFICATE OF SERVICE**

I, Marc A. Al, hereby certify that I have this day served a true and correct copy of the following document via electronic filing to all persons indicated on the attached service list

1. Minnesota Large Industrial Group's Post-Hearing Brief Regarding Phase I (Co<sub>2</sub> Track)

In the Matter of the Investigation into Environmental and Socioeconomic Costs Under Minn. Stat. § 216B.2422, Subd. 3  
PUC Docket No. E-999/CI-14-643  
OAH Docket No. 80-2500-31888

Dated this 24th day of November, 2015

*/s/ Marc A. Al*

\_\_\_\_\_  
Marc A. Al

Subscribed and sworn to before me  
this 24th day of November, 2015

*/s/ Teresa M. Antonson*

\_\_\_\_\_  
Teresa M. Antonson

Notary Public - Minnesota  
My Commission Expires Jan. 31, 2020

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