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September 10, 2015

—Via Electronic Filing—

The Honorable LauraSue Schlatter
Administrative Law Judge
Office of Administrative Hearings
P.O. Box 64620
St. Paul, MN 55164-0620

RE: SURREBUTTAL TESTIMONY – ENVIRONMENTAL COST OF CO₂ EMISSIONS
INVESTIGATION INTO ENVIRONMENTAL AND SOCIOECONOMIC COSTS
MPUC DOCKET NO. E999/CI-14-643
OAH DOCKET NO. 80-2500-31888

Dear Judge Schlatter:

Northern States Power Company, doing business as Xcel Energy, submits the Surrebuttal Testimony in the above-referenced matter for the following witness:

Nicholas Martin Environmental Cost of CO₂ Emissions

This testimony has been filed in eDockets and thereby served on the parties to this proceeding. Consistent with the First Prehearing Order, we are also providing a printed version via courier to your office.

Please contact me at james.r.denniston@xcelenergy.com or (612) 215-4656 if you have any questions regarding this filing.

Sincerely,

/s/

JAMES R. DENNISTON
ASSISTANT GENERAL COUNSEL

Enclosures

c: Service List

Surrebuttal Testimony
Nicholas F. Martin

Before the Minnesota Public Utilities Commission
State of Minnesota

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

Docket No. E999/CI-14-643
OAH Docket No. 80-2500-31888
Exhibit____(NFM-3)

Environmental Cost of CO₂ Emissions

September 10, 2015

Docket No. E999/CI-14-643
Martin Surrebuttal

Table of Contents

I.	INTRODUCTION	1
II.	RESPONSE TO CRITIQUES RAISED BY MULTIPLE WITNESSES	2
	A. POSITION ON THE FEDERAL SCC AND USE OF IWG MODELING OUTPUTS	3
	B. STATISTICAL CRITIQUES	9
	C. DISCOUNT RATES	20
	D. TRANSPARENCY	22
III.	RESPONSE TO DR. WECKER	24
IV.	RESPONSE TO DR. SMITH	28
V.	RESPONSE TO DR. POLASKY	35
VI.	RESPONSE TO DR. HANEMANN	38
VII.	RESPONSE TO DR. MENDELSON	41
VIII.	RESPONSE TO DR. BEZDEK	42
IX.	CONCLUSION	44

1 **I. INTRODUCTION**

2
3 Q. PLEASE STATE YOUR NAME AND TITLE.

4 A. My name is Nicholas F. Martin. My title is Environmental Policy Manager for
5 Xcel Energy Services Inc., which provides services to Northern States Power
6 Company (Xcel Energy, NSPM, or the Company).

7
8 Q. HAVE YOU PREVIOUSLY PROVIDED TESTIMONY IN THIS PROCEEDING?

9 A. Yes. I filed Direct Testimony in which the Company opposed adoption of the
10 Federal Social Cost of Carbon (SCC), instead using the Interagency Working
11 Group's (IWG) modeling outputs to derive a CO₂ environmental cost range
12 that we believe appropriately balances eight standard of review criteria the
13 Company proposed. I filed Rebuttal Testimony responding to the CO₂
14 environmental cost values proposed by other Parties and evaluating them
15 against the Company's proposed criteria.

16
17 Q. PLEASE SUMMARIZE YOUR SURREBUTTAL TESTIMONY.

18 A. My testimony explains why the Company, while opposing adoption of the
19 four Federal SCC point estimates, used the IWG's modeling outputs as a
20 reasonable and best available starting point to derive our proposed CO₂
21 environmental costs range. I respond to statistical critiques raised by several
22 parties, explaining why the Company chose the percentiles we used to
23 bookend our range; why we feel these are more appropriate than the mean,
24 median, or other measures; and why they strike the best balance between
25 uncertainty, risk tolerance and practicability. I explain why we chose to equally
26 weight discount rates, a crucial variable in the SCC calculation about which no
27 consensus exists, either in the economics literature or among Parties to this

1 proceeding. I highlight the transparency, replicability and updateability of the
2 Company's methods.

3
4 Q. WHAT IS THE ORGANIZATION OF YOUR TESTIMONY?

5 A. This testimony responds to critiques by Drs. Wecker, Smith, Hanemann,
6 Polasky, Mendelsohn and Bezdek. Section II addresses critiques raised by
7 more than one witness; Sections III to VIII respond to specific witnesses.
8 Section IX concludes.

9
10 **II. RESPONSE TO CRITIQUES RAISED BY MULTIPLE WITNESSES**

11
12 Q. WHAT IS THE PURPOSE OF THIS SECTION?

13 A. This section responds to critiques raised by more than one witness on the
14 following grounds:

- 15 • The Company's use of the IWG modeling data as our starting point, despite
16 acknowledged flaws in the Federal SCC, as well as our contention that the
17 SCC's intended purpose is sufficiently different from integrated resource
18 planning that the Commission should not adopt the four SCC point
19 estimates;
- 20 • Statistical issues, including why the Company chose the 25th and 75th
21 percentiles for our initial range, and why we oppose use of the mean,
22 median, and 95th percentiles;
- 23 • Discount rates, including the Company's choice to equally weight the SCC
24 values calculated at each of the IWG's three discount rates;
- 25 • The transparency of the Company's methods and choices.

1 **A. Position on the Federal SCC and Use of IWG Modeling Outputs**

2 Q. DOES THE COMPANY ENDORSE THE FEDERAL SCC?

3 A. No. Drs. Wecker, Smith and Bezdek note that the Company pointed to
4 methodological and procedural flaws in the Federal SCC development
5 process, yet used the IWG’s raw modeling outputs as the starting point for
6 developing our CO₂ environmental costs range. They suggest that we
7 implicitly accept and endorse the Federal SCC.

8
9 My Direct and Rebuttal Testimony make clear that the Company *does not*
10 *endorse* adoption of the Federal SCC as this is conventionally understood: the
11 four point estimates published in the executive summary of the SCC Technical
12 Support Documents (TSDs), which represent the average across Integrated
13 Assessment Models (IAMs) at 2.5, 3 and 5 percent discount rates, and the 95th
14 percentile across IAMs at 3 percent discount rate. I explained why the
15 Company opposes adoption of *any* falsely precise point estimate in an area as
16 rife with uncertainty as predicting climate change and the damages it may
17 cause. I addressed why each of the SCC point estimates is subject to flaws:
18 three represent the simple average of a non-normal probability distribution of
19 150,000 values, and the fourth represents one extreme of a probability
20 distribution without the corresponding 5th percentile. I also highlighted
21 procedural flaws in the Federal SCC development process – notably lack of
22 scientific peer review and limited public consultation – some of which the
23 IWG acknowledged in its response to public comments.¹ I have criticized
24 aspects of the IWG’s methodology and do not endorse the essence of its work
25 product, the four point estimates, for adoption by the Commission.

26

¹ IWG July 2015 Response to Public Comments, page 5 (regarding lack of expert review) and 39 (regarding public consultation).

1 Q. DID THE COMPANY USE THE IWG'S MODELING OUTPUTS?

2 A. Yes. The Company relied on the modeling outputs from the IAMs the IWG
3 used in developing the SCC, but used different methods to examine and
4 condense those results into the bookends of the range we proposed. Whereas
5 the IWG took simple averages and the 95th percentile across IAMs, we
6 aggregated the results and created an initial range based on the 25th percentile
7 at 5 percent discount rate to the 75th percentile at 2.5 percent discount rate – a
8 range that included approximately three fourths of all IAM predictions for a
9 given emission year. In order to remain agnostic on the critical normative
10 question of discount rate choice, we then equally weighted the values at each
11 discount rate, which had the effect of narrowing the range. I explained in my
12 Direct Testimony, and will explain again below, why the Company made these
13 choices – choices that were made fully transparent and were not arbitrary, but
14 involved an element of policy judgment about the appropriate balancing of
15 various considerations, as do the recommendations made by all other Parties.

16

17 Q. IF YOU ACKNOWLEDGE FLAWS IN THE FEDERAL SCC, WHY DID YOU USE THE
18 IWG'S MODELING OUTPUTS?

19 A. The Commission mandates the use of a “reasonable and best available
20 measure,” not a perfect measure, and mandates the use of a damage cost
21 approach. The Company considered various alternatives prior to settling on
22 our approach (Martin Direct, pages 50-52). We believed, and continue to
23 believe, that an estimate of the cost of compliance with carbon regulations –
24 such as the regulatory cost range mandated by the Commission under Minn.
25 Stat. §216H.06 – even while not explicitly estimating climate damages, is
26 subject to less uncertainty than the Federal SCC and could be a reasonable
27 proxy for externality damages. However, the Commission has mandated the

1 use of a damage cost approach rather than a regulatory cost approach.²

2
3 Because we believed the four Federal SCC point estimates do not constitute a
4 reasonable and best available measure, the Company then considered two
5 options: 1) derive a new damage cost estimate by modeling climate damages,
6 using an IAM or other methods, or 2) use the IWG modeling outputs as a
7 starting point, but find a way to make them more practicable and appropriate
8 for integrated resource planning in Minnesota. The first option would have
9 required the Company to make the myriad scientific and subjective policy
10 judgments that witnesses who took this approach (Dr. Smith and Dr.
11 Mendelsohn) have made, and would also have made our proposed range, like
12 theirs, difficult and costly to update. Instead, we chose the second option,
13 using the IWG's raw modeling outputs but creating a method to derive from
14 them a range that we believe appropriately balances the Company's eight
15 proposed standard of review criteria.

16
17 The IWG's modeling outputs are far from perfect, but no other witnesses
18 have proposed a clearly superior damage cost approach that does not involve
19 subjective judgments of their own and/or require laborious new modeling
20 each time the Commission updated its CO₂ environmental cost range.

21
22 Q. DID YOU ACCEPT THE IWG'S "FRAMING ASSUMPTIONS"?

23 A. Drs. Smith and Wecker note that the Company, by using the IWG's modeling
24 outputs, effectively accepted its "analytical framing assumptions" including
25 global scope of damage assessment, three discount rates, modeling horizon to

² NOTICE AND ORDER FOR HEARING. *In the Matter of the Investigation into Environmental and Socioeconomic Costs Under Minn. Stat. § 216B.2422, Subd. 3.* Docket Nos. E999/CI-00-1636 and E999/CI-14-643. October 15, 2014, page 8.

1 2300, “last ton” approach to damage assessment, treatment of equilibrium
2 climate sensitivity, selection of three IAMs (DICE, FUND and PAGE) and
3 not others, and use of five Stanford EMF-22 socioeconomic scenarios and not
4 others (Smith Rebuttal, page 10; Wecker Rebuttal, paragraph 14). This is
5 correct.

6
7 Three of these choices – the treatment of equilibrium climate sensitivity,
8 selection of IAMs, and use of EMF-22 scenarios – represent scientific
9 decisions where the Company lacks expertise to substitute its judgment for
10 that of the IWG and the climate scientists and economists on which it relied.
11 The basic climate science behind the SCC, as well as the three IAMs and five
12 EMF-22 scenarios, represent the work of credible experts and/or the
13 Intergovernmental Panel on Climate Change. This work has been extensively
14 peer-reviewed. We accepted these as a reasonable and best available starting
15 point, while disagreeing with how the IWG aggregated its results and stating
16 why the four SCC point estimates are inappropriate for adoption.

17
18 Four other choices – the geographic scope of damage assessment, choice of
19 discount rates, modeling horizon, and choice of how to model incremental
20 emissions – are not objective scientific choices, but rather inherently and
21 unavoidably subjective policy judgments (Martin Rebuttal, section V; see also
22 Smith Direct, page 16). The Company declined to make different policy
23 judgments on these matters, but I acknowledged in my Rebuttal Testimony
24 that the Commission is not bound to the IWG’s policy judgments. I indicated
25 whether and how the Company’s CO₂ environmental cost range could be
26 adjusted if the Commission makes a different policy judgment from the IWG
27 (Martin Rebuttal, section V).

1 Q. WHAT ARE THE KEY DIFFERENCES BETWEEN THE FEDERAL SCC'S INTENDED
2 PURPOSE AND INTEGRATED RESOURCE PLANNING?

3 A. Drs. Polasky and Hanemann contend that there are no significant differences
4 between federal regulatory impact analysis, which they acknowledge to be the
5 SCC's intended purpose, and Commission decisions; they argue that the SCC
6 is equally well suited to establishing external CO₂ costs for evaluating and
7 selecting resource options in Commission proceedings (Polasky Rebuttal, page
8 33; Hanemann Rebuttal, pages 16-17). I agree that there are similarities, but
9 there are also important differences. These involve understanding 1) how the
10 SCC is used in federal rulemakings, and 2) the problem of false precision.

11

12 The Federal SCC, when used for regulatory impact analysis under Executive
13 Order 12866, is only used to estimate whether the benefits of a proposed
14 federal regulation exceed its costs. It is not used to determine how to design
15 the regulation, which depends instead on the authorities granted to the
16 relevant federal agency by statute. To take a recent example: when EPA
17 developed its Clean Power Plan regulating CO₂ emissions from existing power
18 plants, the design and stringency of the regulation were based on EPA's view
19 of the "Best System of Emission Reduction" as defined in section 111(d) of
20 the Clean Air Act. The Federal SCC played no part in EPA's evaluation of
21 what CO₂ reduction measures were feasible, cost-effective, or adequately
22 demonstrated, nor was it relied on to determine how stringent the targets
23 should be. It was only used *ex post facto* to determine whether the regulation
24 EPA had written would be expected to have overall benefits in excess of its
25 overall costs, to satisfy Executive Order 12866. The SCC also plays no role in
26 determining how states and utilities implement the Clean Power Plan, does
27 not determine the compliance options available, and is not a "price on

1 carbon” in the event states choose to create CO₂ trading markets. Instead, the
2 Clean Power Plan gives states and utilities flexibility in deciding how to
3 achieve its targets, balancing the required CO₂ reductions with customer costs,
4 reliability, fuel diversity and other factors. In contrast, using the SCC for
5 integrated resource planning could potentially determine *how* to achieve CO₂
6 reductions by driving resource choices, such as what to build and what to
7 retire, that have significant customer cost impacts and are not easy to reverse.

8
9 This potentially greater impact of the SCC in integrated resource planning, as
10 compared to federal regulatory impact analysis, points to the second
11 consideration: false precision. Again using the example of the Clean Power
12 Plan: when EPA conducted its Executive Order 12866 analysis, EPA
13 concluded that benefits of the rule would exceed costs *at all four levels of the*
14 *SCC* (average at 2.5, 3 and 5 percent discount rates and 95th percentile at 3
15 percent discount rate).³ In other words, precision was not important: it was
16 immaterial whether the “correct” value of damages from an incremental ton
17 of CO₂ is \$12 or \$120, since benefits exceeded costs either way and therefore
18 the regulation was in EPA’s view warranted. The SCC would play no role in
19 *how* states and utilities achieve the required CO₂ reductions. However, whether
20 the “correct” value of the SCC is \$12 or \$120 matters a great deal in integrated
21 resource planning: these two values could point to dramatically different
22 resource mixes, with different implications for customer costs, reliability, fuel
23 diversity and other factors. A falsely precise value could dictate not whether to
24 reduce CO₂, but to a great extent *how* to do it. If the Commission assumes the
25 “correct” SCC is \$120 when it is in fact \$12, the Commission might approve
26 long-term generation investments or retirements that could unnecessarily and

³ U.S. Environmental Protection Agency. August 2015. *Regulatory Impact Analysis for the Clean Power Plan Final Rule*. See the executive summary tables ES-7 through ES-10.

1 prematurely impose higher electricity costs on utility customers.

2
3 In my view this does not mean that the IWG's modeling cannot be used at all.
4 It does illustrate why the Commission should not adopt a single, or even all
5 four, falsely precise SCC point estimates. Instead, the Company recommends
6 looking at the full range of IAM outputs and using statistical methods to
7 define a range that balances uncertainty, risk tolerance and practicability, then
8 giving each end of this range equal weight in planning sensitivities. This is
9 what my Direct Testimony proposed.

10
11 **B. Statistical Critiques**

12 Q. SOME PARTIES DEFEND THE IWG'S USE OF THE MEAN AND ASSERT THAT THE
13 COMPANY HAS ADVOCATED USE OF THE MEDIAN. IS THIS CORRECT?

14 A. No. Drs. Polasky and Hanemann assert that the Company uses the median
15 rather than the mean (Polasky Rebuttal, page 36; Hanemann Rebuttal, page
16 69). This is incorrect. The Company did argue against adopting the three mean
17 estimates, but we did not propose adopting the median instead. Instead, we
18 used the 25th percentile at 5 percent discount rate and the 75th percentile at 2.5
19 percent discount rate as the low and high bounds of our initial range, then
20 equally weighted the values at each discount rate at each end of this range. The
21 median would be a single point estimate and I do not recommend it.

22
23 Q. WHY DO YOU BELIEVE IT IS MORE APPROPRIATE TO USE PERCENTILE BOUNDS
24 RATHER THAN THE MEAN OR MEDIAN?

25 A. Drs. Polasky, Hanemann, and Smith defend the use of the mean despite the
26 non-normal, right-skewed shape of the SCC probability distributions. Dr.
27 Polasky, quoting the IWG's July 2015 response to public comments, argues

1 that the median generally reflects a more typical outcome, while the mean
2 gives full weight the tails of a probability distribution (Polasky Rebuttal, page
3 37). He argues that the mean better incorporates information about the
4 magnitude as well as likelihood of damages and asserts that “with climate
5 change, high damage outcomes are the ones we should be most concerned
6 about so that ignoring information about potential high damages is particularly
7 problematic” (Polasky Rebuttal, page 37). Dr. Hanemann similarly defends the
8 IWG’s use of the mean (Hanemann Rebuttal, pages 65-69). Dr. Smith, like the
9 IWG, takes the mean across IAM estimates.

10
11 The SCC probability distribution is strongly skewed, with a long right tail of
12 high-damage estimates that have a low probability of occurring (see Martin
13 Direct, Figure 4 on page 27). These pull the mean estimate upward, while
14 having less effect on the median. Whether this makes the mean appropriate
15 depends to some extent on one’s view of whether one should give greater
16 weight to low-probability but possibly high damages, or low-probability but
17 possibly low damages. If the IAMs fully captured both low and high damages,
18 this would be immaterial; the mean would reflect the influence of both.
19 However, the IAMs incompletely capture both low and high damages. They
20 incompletely capture possible high damages because they omit some non-
21 catastrophic damages, and only partially model catastrophic damages. They
22 incompletely capture possible low damages because they only partially model
23 adaptation, and do not endogenously model technological change (i.e., the
24 possibility that future societies innovate to reduce CO₂ emissions in response
25 to experienced climate damages). The tails of the SCC distribution, which Dr.
26 Polasky asserts the mean is intended to reflect, may fail to capture the actual
27 value of future climate damages in either direction, and whether the errors and

1 omissions on the high side exceed those on the low side, or vice versa, is very
2 difficult to know.⁴

3
4 The Company took the IWG’s modeling results as they are – i.e., with the
5 awareness that they incompletely capture both low and high damages, and
6 without presupposing which omissions are more significant – and then rather
7 than using the mean or the median, proposed percentiles that we believe strike
8 an appropriate balance of accounting for uncertainty, risk tolerance, and
9 practicability. Other witnesses may differ on what that balance should be, and
10 therefore what percentiles to use, as well as on the subjective policy judgments
11 (global vs. U.S. damages and so on) embedded in creating the distribution of
12 values in the first place. There is room for legitimate debate, but again, we do
13 not feel that the Commission should adopt a mean, median, 95th percentile, or
14 any other falsely precise point estimate.

15
16 Q. WERE THE COMPANY’S STATISTICAL CHOICES – PARTICULARLY USE OF THE
17 25TH AND 75TH PERCENTILES – “ARBITRARY AND UNPRINCIPLED”?

18 A. No. Drs. Wecker, Smith, Polasky and Hanemann all critique the Company’s
19 choice to use percentiles, and/or the specific percentiles we chose. Dr.
20 Wecker calls our choices arbitrary and unprincipled – that is, “lacking
21 apparent, rigorous foundation in established principles of statistics or applied
22 mathematics, or any other explicitly identified or clearly implied field of
23 expertise” (Wecker Rebuttal, paragraph 20). However, taking percentiles of a
24 set of 150,000 values is hardly extraordinary; it has an apparent and rigorous

⁴ Note Dr. Tol’s response on this issue: “Dr. Polasky argues that estimates of the impacts of climate change are incomplete and underestimates. Impact estimates are indeed incomplete. However, the models that are used to estimate the social cost of carbon include all impacts for which a global impact estimate is available. Therefore, the size and indeed the sign of the missing impacts are unknown. Dr. Polasky’s assertion that the missing impacts are sizable and negative, is pure speculation” (Tol Rebuttal, page 8).

1 foundation in established principles of statistics. Our rationale for choosing
2 the 25th and 75th percentiles is described in my Direct Testimony and reiterated
3 below. Finally, the Brattle Group's (Brattle) expertise in the application of
4 statistics to electric utility resource planning is explicitly identified in
5 Exhibit____(NFM-1), Schedule 9.

6
7 Q. SOME WITNESSES ASSERT THAT THE COMPANY'S STATISTICAL CHOICES ARE
8 SUBJECTIVE. DO YOU AGREE?

9 A. There is an element of subjective policy judgment in *all* witnesses' proposals.
10 With regard to the choice of percentiles, since theoretically any percentiles
11 could have been used, it was necessary to strike a balance between capturing
12 the inherent uncertainty in climate damage estimation; selecting an appropriate
13 degree of risk tolerance, defined in my testimony as the risk that the
14 Commission's CO₂ environmental cost range may not include the actual value
15 of future climate damages (Martin Direct, pages 56-57); and the practicability
16 of the range when applied to integrated resource planning. I reiterate here how
17 we struck this balance.

18
19 The Company initially asked Brattle to calculate the 1st, 5th, 10th, 25th, 50th, 75th,
20 90th, 95th, and 99th percentiles of each distribution of 150,000 SCC estimates
21 for a given discount rate and emission year (Martin Direct, page 54). This
22 range was very wide: e.g., for emission year 2020, the 1st to 99th percentiles
23 resulted in an SCC range from *negative* \$9/ton (indicating a net benefit of \$9
24 per ton of CO₂) to positive damages of over \$600/ton. If minimizing risk
25 tolerance were the sole criterion, the Commission would choose these
26 percentiles, since this range implies the lowest risk that the Commission's
27 range will not include the actual value (since it includes almost all the IAM

1 predictions for 2020). However, there is no sole criterion but rather a balance
2 of criteria. The 1st to 99th percentile range would fail on the practicability
3 criterion, since the 1st percentile value would favor integrated resource
4 planning scenarios that include an increased amount of CO₂-emitting fossil
5 generation over renewable and nuclear in a utility's resource mix, while the
6 99th percentile value would favor scenarios with significant fossil generation
7 retirements and significant additions of non-CO₂ emitting generation. In other
8 words, two equally weighted ends of the CO₂ environmental cost range would
9 simply point in diametrically opposed directions, not providing useful
10 information for Commission decisions. Other possible percentiles – e.g. those
11 where the low percentile indicates slightly positive damages, and the high
12 percentile indicates very high damages – would still point to such diametrically
13 opposed resource planning decisions that they would not be practicable, as
14 required by Minn. Stat. § 216B.2422, subd. 3(a).

15
16 Therefore the Company chose the 25th percentile at 5 percent discount rate,
17 and the 75th percentile at 2.5 percent discount rate, for our initial range. This
18 excluded approximately one fourth of the IAM predictions – low and high
19 SCC values that have a low probability of occurring – but retained
20 approximately three fourths of all SCC estimates for a given emission year
21 (Martin Direct, pages 62-63). We viewed this as a subjectively appropriate
22 balance of risk tolerance with practicability. When we equally weighted the
23 values for the three discount rates at each end of our range, the resulting range
24 was narrower, corresponding to the 36th and 74th percentiles of the combined
25 discount rate distribution. This means more values were excluded, but the
26 narrowing was risk averse from a climate damages perspective because it
27 excluded more low values (36 percent) than high values (26 percent) (Martin

1 Direct, page 64).

2
3 Thus, the Company's balancing of uncertainty, risk tolerance and practicability
4 was subjective, but not arbitrary or unprincipled. We acknowledge that other
5 witnesses may have a different subjective view of what balance is appropriate.
6

7 Q. WHAT OBJECTION DOES DR. SMITH MAKE TO THE COMPANY'S PERCENTILES?

8 A. Dr. Smith notes that the IWG's choice to report the mean across IAMs "may
9 not always be appropriate, depending on the decision context and on the
10 nature of the underlying probability distribution" (Smith Rebuttal, page 6).
11 This appears to acknowledge that averaging a non-normal probability
12 distribution with high-damage, low-probability outliers may not be appropriate
13 – though Dr. Smith has taken exactly this approach, averaging the 150,000
14 SCC values for each emission year/discount rate distribution after applying
15 her alternate framing assumptions. Dr. Smith asserts that the Company's
16 choice to use the 25th and 75th percentiles lacks a statistical foundation or
17 objective principle, and that other percentiles could be used to identify
18 narrower and lower SCC ranges, or wider and higher SCC ranges, with the
19 same probability of being accurate (Smith Rebuttal, page 3). I disagree. Any
20 other symmetrical range (10th and 90th, 30th and 70th, etc.) would exclude more
21 or fewer IAM model predictions. It would thus not have the same probability
22 of being "accurate," i.e., of containing the actual value of future climate
23 damages as predicted by the IWG methodology.
24

25 Q. WHAT OTHER PERCENTILES DOES DR. POLASKY SUGGEST COULD BE USED?

26 A. Dr. Polasky asserts that the Company's use of 25th and 75th percentiles is
27 arbitrary and that one could just as well use the 5th to the 95th percentiles,

1 which “would encompass 90 percent of the outcomes produced by the IWG,
2 whereas Martin’s percentiles would only cover 50 percent of the outcomes.”
3 He also asserts that the range from the 25th to 75th percentiles “creates a set of
4 values that are less practical for use in resource planning decisions” (Polasky
5 Rebuttal, pages 40-41). There are multiple errors in this statement.

6
7 First, Dr. Polasky is incorrect that the Company’s initial range covers only 50
8 percent of the outcomes. The range from the 25th percentile at 5 percent
9 discount rate to the 75th percentile at 2.5 percent discount rate includes about
10 75 percent of the 450,000 SCC estimates for a given emission year (Martin
11 Direct, page 63).

12
13 Second, it is hard to see how a range from the 25th to 75th percentiles is “less
14 practical for use in resource planning decisions” than a range from the 5th to
15 the 95th percentiles. The 5th to 95th percentile range would include more of the
16 IAM model outputs and thus represent a lower risk tolerance, but these values
17 – for emission year 2020 at 3 percent discount rate, \$1.80 and \$142.60 nominal
18 dollars per short ton respectively – would simply point in opposite directions
19 and thus be impractical for resource planning decisions.

20
21 Dr. Polasky also asserts that “it is not the case that the 1st and 99th percentiles
22 are not practical for use; rather the distribution of outcomes has a very wide
23 range of values” (Polasky Rebuttal, page 42). For emission year 2020 at 3
24 percent discount rate, the 1st percentile value is *negative* \$8.80, i.e. a net benefit
25 of \$8.80 per ton of CO₂ emitted, which would point toward resource plans
26 that replace expiring renewable power purchase agreements and nuclear
27 resources reaching the end of their current license terms with fossil

1 generation. The 99th percentile value of \$452.30 would argue for retiring most
2 fossil generation and replacing it with renewable or other non-CO₂ emitting
3 generation resources. Again, the two values would simply point in opposite
4 directions, leaving the Commission no real option but to discard them both. It
5 is hard to see how this would be practicable.

6
7 Q. WHY NOT USE THE 95TH PERCENTILE VALUE?

8 A. Dr. Hanemann disagrees with our decision to set the high end of our initial
9 range at the 75th percentile, eliminating the 95th percentile value included in the
10 TSD executive summaries. He believes the 95th percentile is appropriate
11 because it helps capture low-risk but potentially catastrophic outcomes
12 (Hanemann Rebuttal, page 70). However, while it is true the IAMs may fail to
13 capture all damages including catastrophic damages, making it possible that
14 the SCC is underestimated – the IWG’s rationale for presenting the 95th
15 percentile – the IAMs’ incomplete modeling of adaptation and complete lack
16 of endogenous modeling of technological change also makes it possible that
17 the SCC is overestimated, which the 5th percentile would help capture (Martin
18 Rebuttal, pages 16-17). Therefore adopting the 95th percentile would have to
19 be accompanied by adopting the 5th percentile. This would not meet the
20 practicability criterion since the two would simply point in opposite directions.

21
22 Q. IS DR. HANEMANN’S EXAMPLE OF A PLANE CRASH ON POINT?

23 A. No. Dr. Hanemann notes that “we wouldn’t get on a plane if there was a 5%
24 chance of the plane crashing, but we’re treating the climate with that same
25 level of risk in a very offhand, complacent way” (Hanemann Direct, page 71).
26 This example differs in important ways from the problem of determining an
27 appropriate level of risk tolerance for future climate damages.

1 In Dr. Hanemann's example, you would not get on the plane because there is
2 an infinite cost to you if the plane crashes. There also exist other, lower-cost
3 alternatives such as driving. You also have a clear understanding of the risk
4 up front (Dr. Hanemann's example suggests a known 1-in-20 chance of
5 crashing). However, when estimating the potential damages caused by climate
6 change, we do not have a clear understanding of the probability distribution at
7 the tails. Even if the distribution provided by the IWG is correct, there are
8 costs associated with including a very high SCC in planning. By definition
9 there is a 95 percent chance the SCC value will be set too high if it is set at the
10 95th percentile. Risk tolerances must be bounded in good public
11 policymaking, and it is inappropriate for the Commission to intentionally set
12 the SCC at a level that is by definition 95 percent likely of being too high.

13
14 Q. IS DR. POLASKY'S EXAMPLE OF HOME INSURANCE ON POINT?

15 A. No. Dr. Polasky uses the example of pricing home insurance to argue that the
16 mean, because it captures low-probability high-damage outcomes, is more
17 appropriate than the median. Again, I have not proposed the median, but I
18 respond because I have argued against the IWG's mean values.

19
20 Dr. Polasky asserts that establishing a value for the SCC and pricing home
21 insurance are similar because both involve uncertainty about future damages:

22 "If we could be certain there would be no damages to our house over
23 the next year, the value of home insurance would be zero. But the
24 value of insurance is greater than zero because there is some, perhaps
25 small, probability that a damage-causing event will happen (e.g., severe
26 storm, fire). Suppose there is a 5 percent chance of such an event
27 occurring. That means there is a 95 percent chance that no such event
28 will occur. In other words, 95 times out of 100, the possible future cost
29 of damage to our home is \$0.0. Five times out of 100, however, the
30 cost of those damages could be quite large. If we calculate the median

1 of expected damages over the coming year, it is zero. In fact, the range
2 from the 25th to the 75th percentile outcomes would also be zero. This
3 is true regardless of how high the cost is in the five times out of 100
4 that our home will suffer some damage” (Polasky Rebuttal, page 38).

5 Dr. Polasky is correct that the price of home insurance takes into account the
6 risk of very unlikely but very damaging events. Dr. Polasky is also correct that
7 the median, 25th and 75th percentile outcomes would be zero in this situation.
8 However, this example significantly differs from the problem of establishing a
9 value for the SCC. First, in Dr. Polasky’s example the risk entirely consists of
10 very improbable (1-in-20) but highly damaging events. The damages each year
11 are either zero or extremely high. In contrast, the modeling performed by the
12 IWG suggests the correct SCC value lies on a continuum and may be between
13 zero (or slightly negative) and very high numbers. The average value for the
14 SCC therefore lies between the 25th and 75th percentile, whereas in Dr.
15 Polasky’s example it does not.

16
17 Second, the IAMs are not designed to accurately quantify the risks posed by
18 the extremely unlikely but highly damaging “tail risk” events in Dr. Polasky’s
19 example. In the case of home insurance, setting the appropriate price requires
20 an accurate assessment of the likelihood of a damage-causing event. For
21 example, to protect against an event causing damages of \$100,000 that occurs
22 every ten years, customers should pay roughly \$10,000 per year (ignoring the
23 time value of money); if every 20 years, \$5,000 per year; etc. Companies
24 providing home insurance have a tremendous amount of historical data with
25 which to estimate the probability of such events and set an appropriate price.
26 That is not the case with the SCC, where there is no historical data showing
27 the likelihood of so-called climate “tail risks” (low-probability, extremely
28 damaging scenarios). Nor is there much empirical data to validate the

1 damages predicted by the IAMs at higher temperature changes. The IWG
2 results for tail risks are therefore unreliable, as they are extremely sensitive to
3 the structure and assumptions of each IAM, whose deficiencies at estimating
4 even the more central portions of the damages distribution have already been
5 discussed in my testimony and that of other witnesses.

6
7 Q. WHY HAVE YOU PROPOSED ONLY TWO SUMMARY STATISTICS – THE LOW AND
8 HIGH BOUNDS – FOR EACH EMISSION YEAR?

9 A. Dr. Wecker asserts that the Company has suppressed the information
10 available for decision-making by reducing the SCC to two descriptive statistics
11 (Wecker Rebuttal, paragraph 18). It would indeed have been possible to
12 provide the Commission with many more CO₂ environmental cost values. In
13 the extreme, the Commission could adopt all 450 SCC values presented in the
14 TSD Appendix tables A2, A3 and A4, where they are listed separately by IAM,
15 socioeconomic scenario, and discount rate, for the average and 1st, 5th, 10th,
16 25th, 50th, 75th, 90th, 95th, and 99th percentiles.⁵ However, this would not be
17 practicable or useful. We could also have presented the low and high bounds
18 of our range separately by discount rate, resulting in six values instead of two.

19
20 However the Commission has, since the 1990s, set two values, low and high,
21 for each pollutant.⁶ Accordingly, the Company proposed two ends of a range
22 that balances uncertainty, risk tolerance and practicability, and is agnostic on
23 the crucial question of discount rate. We suggested this would be appropriate
24 for Commission adoption as long as neither end of the range, nor any single

⁵ Interagency Working Group on Social Cost of Carbon, United States Government. May 2013, revised July 2015. *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866*. See Exhibit ____ (NFM-2), Schedule 1. Pages 18-19.

⁶ Notice of Updated Environmental Externality Values. *In the Matter of the Investigation into Environmental and Socioeconomic Costs under Minnesota Stat. Section 216 B 2422, Subd. 3*. May 27, 2015.

1 value in between, is given greater weight (Martin Direct at pages 8, 70).

3 **C. Discount Rates**

4 Q. WHY DID THE COMPANY EQUALLY WEIGHT DISCOUNT RATES?

5 A. Several witnesses argued that it was inappropriate to equally weight the three
6 discount rates because their value is not uncertain, merely subjective and
7 controversial (Wecker Rebuttal, paragraph 36; Smith Rebuttal, pages 5-6;
8 Mendelsohn Rebuttal, page 8.) I agree discount rate is not an uncertain model
9 parameter (like, for example, equilibrium climate sensitivity), but an inherently
10 subjective and normative policy decision about how to weight present
11 consumption against future consumption, and in this case the welfare of the
12 present generation against the welfare of future generations. It is a crucial
13 variable in the SCC calculation, exerting more influence on the results than
14 any other single factor, and yet, as noted by the IWG, “the choice of a
15 discount rate, especially over long periods of time, raises highly contested and
16 exceedingly difficult questions of science, economics, philosophy, and law...
17 there is no consensus about what rates to use in this context.”⁷

18
19 The IWG discussed its rationale for selecting discount rates of 2.5, 3 and 5
20 percent.⁸ It also discussed the potential use of lower discount rates – e.g., 1.4
21 percent, used in the Stern Report⁹ – and higher discount rates – e.g., 7 percent,
22 as recommended in applicable OMB guidance.¹⁰ The IWG ultimately chose

⁷ Interagency Working Group on Social Cost of Carbon, United States Government. February 2010. *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866*. Attached to my Direct Testimony as Exhibit ____ (NFM-1), Schedule 6. Page 17.

⁸ February 2010 TSD, Exhibit ____ (NFM-1), Schedule 6, pages 17-23. See also IWG July 2015 Response to Public Comments, pages 20-24.

⁹ Nicholas Stern, *The Economics of Climate Change: The Stern Review*, Cambridge University Press, Cambridge, U.K. 2007.

¹⁰ OMB Circular A-94, section 8. See https://www.whitehouse.gov/omb/circulars_a094#8.

1 three discount rates, and not lower or higher ones, and recommended that
2 federal agencies conduct regulatory impact analysis using all three.¹¹

3
4 The Company decided not to substitute our judgment for the IWG's, either by
5 recommending rates below 2.5 percent or above 5 percent, or by discarding
6 any of the three discount rates used by the IWG. We decided to retain the
7 SCC values calculated at all three discount rates because in our view there is
8 no neutral or objective evidentiary basis for discarding any of the three
9 (Martin Direct, pages 43-47 and 59-60; Martin Rebuttal, pages 41-43). Our
10 equal weighting the SCC values for each discount rate at each end of our range
11 is agnostic on discount rate choice and gives each rate equal emphasis.

12
13 Q. WHY NOT PRESENT YOUR PROPOSED RANGE SEPARATELY BY DISCOUNT RATE?

14 A. The Company could have presented CO₂ environmental cost values for each
15 discount rate separately. This would have resulted in six CO₂ values for each
16 emission year: e.g. for 2020, values of \$2.48, \$13.10, and \$20.82 at the 25th
17 percentile and values of \$13.17, \$43.94, and \$67.08 at the 75th percentile
18 (Figure 1 in Martin Rebuttal, page 7). The Company felt recommending six
19 different values per year did not satisfy the practicability criterion. First, this
20 many values would present many conflicting signals for integrated resource
21 planning. Second, it would be inconsistent with the Commission's precedent
22 since the 1990s of adopting two values (low and high) for each pollutant.
23 Third, the mid-range values would have similar implications for integrated
24 resource planning, despite representing completely different assumptions. For
25 example, \$13.10, the 25th percentile value at 3 percent discount rate, and
26 \$13.17, the 75th percentile value at 5 percent discount rate, would be virtually

¹¹ November 2013 TSD, Exhibit ____ (NFM-1), Schedule 2, page 12.

1 identical in their resource planning implications, yet represent completely
2 different policy judgments about how to weight the welfare of future
3 generations, and in which direction to be risk-averse (toward the 75th
4 percentile, putting greater emphasis on possible high damages, or toward the
5 25th percentile, putting greater emphasis on possible low damages). Fourth, the
6 low and high ends – \$2.48 and \$67.08 – would merely point in opposite
7 directions for planning.

8
9 Q. COULD THE COMMISSION ADJUST THE COMPANY’S RANGE IF THE
10 COMMISSION MAKES A DIFFERENT POLICY JUDGMENT ON DISCOUNT RATES?

11 A. Yes. If the Commission chooses differently from the IWG – e.g., chooses to
12 use only 3 and 5 percent discount rates, as it did when it set CO₂ values in the
13 1990s¹² – the Company’s method is easy to adjust. The Commission could
14 drop the SCC estimates for the discarded discount rate from the probability
15 distribution, reducing the total estimates from 450,000 to 300,000 per year,
16 then apply the Company’s statistical methods to recalculate the range.

17
18 **D. Transparency**

19 Q. SOME WITNESSES ALLEGE THAT THE FEDERAL SCC DEVELOPMENT PROCESS
20 WAS NOT TRANSPARENT. DO YOU AGREE?

21 A. Yes, I agree as noted in my testimony (Martin Direct, pages 48-50). However,
22 while the Federal SCC development process was not transparent, I do claim
23 that the Company’s methods are transparent.

24
25 Q. HAS THE COMPANY BEEN TRANSPARENT AND FULLY DOCUMENTED ITS

¹² State of Minnesota Office of Administrative Hearings for the Minnesota Public Utilities Commission. Findings of Fact, Conclusions, Recommendation and Memorandum. *In the Matter of the Quantification of Environmental Costs Pursuant to Laws of Minnesota 1993, Chapter 356, Section 3*. Page 36.

1 METHODS?

2 A. Yes. Dr. Wecker maintains that my testimony does not identify any specific
3 statistical method by name, justify the Company's choices, or document the
4 basis for our conscious choices (Wecker Rebuttal, paragraph 19). I
5 emphatically disagree. The Company documented our rationale, methods and
6 data more explicitly than any other witness submitting testimony. First, unlike
7 any other witness, the Company proposed explicit standard of review criteria
8 and discussed how our method balances those criteria.

9
10 Second, we documented our methods, describing how we obtained the IAM
11 model outputs from the IWG; how Brattle aggregated the model outputs and
12 applied well-accepted statistical methods to those data; why we chose the 25th
13 percentile at 5 percent discount rate and the 75th percentile at 2.5 percent
14 discount rate as the low and high bounds of our initial range; why we chose to
15 remain agnostic on discount rate, equally weighting the SCC values at each
16 discount rate; what the resulting values were, and which percentiles of the
17 overall dataset these correspond to (Martin Direct, pages 54-65).

18
19 Third, we provided comprehensive supporting material to ensure that our
20 methods were transparent and to allow other Parties to validate, replicate or
21 revise our methods. Specifically, we provided the raw IAM model outputs for
22 the November 2013 and July 2015 SCC updates on CD-ROM to all Parties;
23 provided the statistical software code Brattle used to calculate our range so
24 that other Parties could use or modify this code if they desire
25 (Exhibit____(NFM-1), Schedule 11); and provided live Excel spreadsheets
26 showing Brattle's work (Exhibit____(NFM-1), Schedule 10 and
27 Exhibit____(NFM-2), Schedule 4). Using these materials, other Parties or the

1 Commission can replicate the Company's work, or create their own range
2 using percentiles, discount rates, or subjective policy judgments they prefer.

3
4 **III. RESPONSE TO DR. WECKER**

5
6 Q. PLEASE ADDRESS DR. WECKER'S ASSERTION THAT YOU ARE NOT A
7 STATISTICIAN.

8 A. This is correct, and my direct and rebuttal testimonies at no point claim that I
9 am a statistician. Instead, they explicitly state (Martin Direct, page 54) that the
10 Company retained Brattle, which has the necessary statistical expertise, to
11 apply statistical methods to the IAM model outputs. Exhibit____(NFM-1),
12 Schedule 9 to my Direct Testimony illustrates Brattle's qualifications in the
13 application of statistics and sampling to public utility commission proceedings,
14 and includes the resumes of the three Brattle principals on whom we relied.
15 Notably, Dr. Hanser holds a Phil.M. in Economics and Mathematical Statistics
16 from Columbia University; has been a member of the American Statistical
17 Association since 1974; served for six years on the American Statistical
18 Association's Advisory Committee to the Energy Information Administration
19 (EIA); has extensive experience applying statistical methods in utility decision-
20 making; and has published extensively in applied statistics and mathematics
21 (Schedule 9, pages 25-49).

22
23 Q. WHAT CRITIQUES DOES DR. WECKER MAKE OF THE COMPANY'S STATISTICAL
24 CHOICES?

25 A. Dr. Wecker asserts that the Company has not employed statistically sound
26 methods in our selection of percentiles; objects to our condensation of the
27 SCC estimates into only two summary statistics by emission year; and objects

1 that we have insufficiently cited peer-reviewed literature in statistics and
2 applied mathematics (Wecker Rebuttal, paragraphs 7, 13, 16-22).

3
4 Q. DID YOU CHOOSE THE STATISTICAL METHODS EMPLOYED?

5 A. No. As noted above, I am not a statistician, so the Company relied on Brattle,
6 which has extensive experience applying statistics to electric utility resource
7 planning and related matters, to evaluate the dataset of 2.25 million SCC
8 estimates from the IAMs and select appropriate statistical methods.

9
10 Q. WHY DID YOU NOT CITE THE STATISTICAL LITERATURE?

11 A. My understanding is that the statistical problem facing Brattle was not
12 inherently a complex one involving advanced statistics or requiring extensive
13 citations. While the number of SCC estimates is large – 2.25 million values –
14 Brattle simply organized that data into logical sub-populations by discount rate
15 and emission year, then calculated various percentiles of those populations – a
16 common and well-accepted statistical technique.

17
18 Q. PLEASE REITERATE HOW BRATTLE APPLIED STATISTICAL METHODS.

19 A. As described in my testimony (Martin Direct, page 55), Brattle aggregated the
20 results of the 15 scenarios (3 IAMs * 5 socioeconomic scenarios) for each
21 discount rate and emission year combination into 15 distributions, each
22 containing 150,000 data points. They repeated this process for each emissions
23 year for which data was provided (2010, 2020, 2030, 2040, and 2050). They
24 then calculated percentiles of each set of 150,000 data points. This appears to
25 me to be a “well-founded, well-established statistical method appropriate to a
26 well-defined problem of a statistical character” (Wecker Rebuttal, paragraph
27 15): the aggregation of the raw data into distributions by discount rate and

1 emission year appears to create a “well-defined problem of a statistical
2 character,” and the calculation of percentiles of a data set is well founded and
3 well established in statistics.

4
5 Q. DR. WECKER OBJECTS TO THE TECHNIQUE OF BOOTSTRAPPING AS
6 NEEDLESSLY COMPLEX. DO YOU AGREE?

7 A. No. The bootstrapping technique used in my testimony is a well-known and
8 robust statistical method. As noted in my Direct Testimony, bootstrapping is
9 “a procedure for estimating sampling error by constructing a simulated
10 population on the basis of the sample, then repeatedly drawing samples from
11 the simulated population.”¹³ One of the uses of bootstrapping is to estimate
12 the variability of a statistic of a population when limited information about the
13 underlying distribution is available. This is the case with the results of the
14 IWG’s modeling. Each of the IAMs used by the IWG relies on uncertain
15 inputs and calculates a probabilistic estimate of the SCC using Monte Carlo
16 methods, although strictly speaking the underlying distributions of those
17 inputs is largely, if not completely, unknown. The output of each IAM model
18 run is 10,000 data points designed to represent the underlying probability
19 distribution of the SCC for that IAM, socioeconomic scenario, discount rate
20 and emission year. Having aggregated the 15 model scenarios for a given
21 discount rate and emission year, Brattle followed a bootstrapping procedure
22 by repeatedly drawing samples from each 150,000-element data set and
23 calculating the 25th and 75th percentiles of each sample. Using this procedure,
24 Brattle was able to estimate the value of the 25th and 75th percentiles of the
25 probability distribution underlying the aggregated data set.

26

¹³ Federal Judicial Center and National Research Council of the National Academies. 2011. Reference Manual on Scientific Evidence, Third Edition. Washington, DC: The National Academies Press.

1 The result of this bootstrapping was estimates of the 25th and 75th percentiles
2 that were very close to the estimates that would be calculated directly by
3 ordering the 150,000 values from smallest to largest and taking the same
4 percentiles. Also, the bootstrapped statistics had very little uncertainty. Due
5 to the large number of data points (150,000), Brattle predicted that the
6 bootstrapped value of the statistic would be very close to the sample statistic.
7 However, the bootstrapping technique is a statistically robust method and, in
8 the face of the uncertainty about the underlying distribution of the inputs,
9 adds a reasonable measure of precaution.

10
11 Q. WAS “USES STATISTICALLY SOUND METHODS” THE COMPANY’S SOLE OR
12 OVERRIDING CRITERION?

13 A. No. Dr. Wecker attempts to reduce my entire testimony to the question of
14 proper statistical qualifications, citations, and methods, but the application of
15 sound statistical methods was in fact only one of eight criteria the Company
16 balanced. We stand by the statistical methods we chose, but we also balanced
17 this criterion with seven others, including reflecting the inherent uncertainty,
18 an appropriate degree of tolerance for the risk that the Commission’s range
19 may not contain the actual value, and practicability. These criteria are equally
20 important for integrated resource planning and other Commission decisions.
21 Dr. Wecker’s resume (Wecker Rebuttal, Exhibit 1) does not indicate he has
22 experience in public utility commission decision-making or electric utility
23 integrated resource planning, so it is understandable that his testimony does
24 not consider the balancing of multiple decision criteria that such proceedings
25 generally require.

26
27 Q. DOES DR. WECKER APPLY STATISTICAL METHODS HE PREFERS?

1 A. He does not. Despite going to great lengths to critique the Company's
2 statistical choices, and maintaining that the applied statistics literature offers
3 more appropriate methods, Dr. Wecker does not apply any of these methods
4 to the IWG data to derive an alternate range. His testimony is a lengthy tirade
5 against our methods without offering the Commission an alternative he
6 believes would be more defensible.

7
8 **IV. RESPONSE TO DR. SMITH**
9

10 Q. WHY DOES DR. SMITH DISAGREE WITH THE COMPANY'S RELIANCE ON THE
11 IWG'S RAW MODELING OUTPUTS?

12 A. Dr. Smith's fundamental criticism of my testimony is not that the Company
13 used the IAMs and the climate science and damage functions embedded in
14 them – since she uses them as well – but that we retained the IWG's
15 “analytical framing assumptions.” Specifically, our approach does not alter the
16 IWG's policy judgments on geographic scope of damage assessment (global
17 damages), choice of discount rates (2.5, 3 and 5 percent), modeling horizon
18 (present to 2300), and treatment of incremental emissions (modeling damages
19 from the “last ton” added to the global GHG inventory) (Smith Rebuttal, page
20 10). I do not agree with Dr. Smith that we “unquestioningly adopt” (Smith
21 Rebuttal, page 3) these assumptions – since in rebuttal we critiqued each
22 assumption, acknowledged the rationale of Dr. Smith and others for alternate
23 assumptions, and indicated how the Company's proposed range could be
24 adjusted if the Commission makes different policy judgments from the IWG.
25 However, our proposed range does retain the IWG's framing assumptions.

26
27 Dr. Smith maintains that her decisions to consider U.S. damages only, discard

1 the 2.5 percent discount rate, truncate the modeling horizon, and model first
2 or average ton are 1) less subjective, with a stronger evidentiary basis, than the
3 IWG's, and 2) are more consistent with Minnesota law and/or Commission
4 precedent in this docket (Smith Rebuttal, page 12). I disagree on both points.
5

6 Q. ARE DR. SMITH'S ALTERNATE FRAMING ASSUMPTIONS MORE EVIDENCE-BASED
7 OR LESS SUBJECTIVE THAN THE IWG'S?

8 A. Generally no. On the geographic scope of damage assessment, Dr. Smith and
9 other witnesses present arguments based in legal rights and economic standing
10 for considering only U.S. or Minnesota damages. Other witnesses and the
11 IWG present equally rational arguments for retaining a focus on global
12 damages because 1) as with other global commons problems, if all
13 jurisdictions considered only domestic damages and benefits, the total amount
14 of CO₂ mitigation globally may be less than optimal for all jurisdictions, and 2)
15 accounting for global benefits may be seen as a way to encourage reciprocal
16 action, rather than something that only becomes appropriate once other
17 jurisdictions are taking reciprocal action.¹⁴ We acknowledged both
18 perspectives, and indicated how the Company's range could be adjusted if the
19 Commission decides a focus on U.S. damages is appropriate (Martin Rebuttal,
20 pages 38-40). This is inherently a policy judgment, and Dr. Smith's focus on
21 U.S. damages is no more objective than the IWG's focus on global damages.
22

23 On the choice of discount rates, it goes without saying that we lack evidence
24 of distant future generations' preferences for how we should weight their
25 welfare. We have evidence of how the present generation weights its own
26 present vs. future consumption, providing a basis for the 3 percent discount

¹⁴ See IWG July 2015 Response to Public Comments, pages 30-32.

1 rate, and evidence in market rates of return for the 5 percent discount rate. We
2 have no evidentiary foundation for assuming that distant future generations
3 would not prefer a discount rate lower than 3 percent. In short, the choice of
4 discount rate is inherently subjective and normative. While the Company
5 chose to remain agnostic on discount rates and not substitute our judgment
6 for the IWG's, we acknowledge that the Commission could decide other
7 discount rates are appropriate, and we indicated how the Company's range
8 could be adjusted accordingly (Martin Rebuttal, page 43).

9
10 On modeling horizon, Dr. Smith's recommendation effectively sets the
11 damages from an incremental emission at zero after 2100 or 2140. I
12 acknowledged that the SCC estimates are more speculative, and more
13 disconnected from empirical data with which to calibrate the IAM damage
14 functions, further out in time and for greater temperature changes. Therefore
15 truncating the modeling horizon does reduce uncertainty and speculation
16 (Martin Rebuttal, pages 43-45). However, climate damages are unlikely to
17 suddenly drop to zero after 2100 or 2140. Modeling horizon remains a policy
18 judgment rather than an objective scientific choice. Practically speaking, the
19 disadvantage of shortening the horizon is that it requires new modeling, which
20 would make the Commission's CO₂ range more difficult to update.

21
22 On the treatment of incremental emissions as the first, last, or average ton, I
23 agreed with Dr. Smith that treating Minnesota emissions as the last ton to be
24 added to the global GHG inventory is likely to overstate damages from those
25 emissions, and therefore overstate benefits from reducing emissions (Martin
26 Rebuttal, page 46). However, her method of adjusting the IAMs to model
27 "first ton" damages – setting business-as-usual global emissions to zero after

1 2020 so that Minnesota emissions can functionally become the first ton added
2 – is entirely unrealistic.¹⁵ I think some compromise between the IWG’s and
3 Dr. Smith’s approach on this methodological issue would be preferable, but
4 lacking such a compromise method, the Company used the IWG’s modeling
5 outputs that represent “last ton” damages. This may cause our range to err on
6 the conservatively high side. Again, this remains a policy judgment, and
7 practically speaking, the disadvantage of re-coding the IAMs to model first ton
8 is that it would make the Commission’s CO₂ range more difficult to update.

9
10 Q. ARE DR. SMITH’S ALTERNATE FRAMING ASSUMPTIONS BETTER SUPPORTED IN
11 MINNESOTA LAW OR COMMISSION PRECEDENT?

12 A. I disagree with Dr. Smith’s assertion that her alternate framing assumptions
13 are more “consistent with Minnesota law” (Smith Rebuttal, page 7), since the
14 applicable statute is silent on all these framing assumptions.¹⁶ As for
15 Commission precedent, the verdict is mixed: on geographic scope, the CO₂
16 values set in the 1990s and used since then are global damage values – losses
17 of global GDP – so precedent is contrary to Dr. Smith’s suggestion. On
18 discount rate, the values set in the 1990s were calculated at 3 and 5 percent
19 discount rates, so precedent is consistent with her suggestion. On modeling
20 horizon, they were based on estimated losses of GDP to the year 2100, not
21 2300, so precedent is consistent with her suggestion. They are average damage
22 values, so precedent is inconsistent with her revised modeling of damages
23 from incremental emissions as the first ton added to the global inventory.¹⁷

24

¹⁵ See also Hanemann Rebuttal, pages 28-29.

¹⁶ Minn. Stat. § 216B.2422, subd. 3(a) merely requires the Commission, “to the extent practicable, quantify and establish a range of environmental costs associated with each method of electricity generation.”

¹⁷ State of Minnesota Office of Administrative Hearings for the Minnesota Public Utilities Commission. Findings of Fact, Conclusions, Recommendation and Memorandum. *In the Matter of the Quantification of Environmental Costs Pursuant to Laws of Minnesota 1993, Chapter 356, Section 3*. Pages 34-37.

1 Q. WHY DOES DR. SMITH BELIEVE THE COMPANY’S RANGE IS NOT A DAMAGE
2 COST APPROACH?

3 A. Dr. Smith maintains that the IAMs do not provide a true damage costs
4 approach because they use highly aggregated damage functions (Smith
5 Rebuttal, page 4) and skip the step of estimating physical impacts on resources
6 (Smith Direct, page 19). This assertion is without basis in the Commission’s
7 definition of a damage cost approach, which according to the original
8 externalities proceeding is simply an approach that places an economic value
9 on the net damage to the environment caused by an energy resource, in
10 contrast to other approaches (regulatory cost, willingness to pay, etc.).¹⁸
11 Nothing in this definition requires disaggregated damage functions or an
12 explicit step estimating physical impacts on resources.¹⁹

13
14 I do agree with Dr. Smith (Smith Rebuttal, page 5) that a regulatory cost proxy
15 such as the range mandated under Minn. Stat. §216H.06 would be subject to
16 far less uncertainty than the Federal SCC. However, this is a regulatory cost
17 approach, and because the Commission has mandated a damage cost
18 approach, we sought a reasonable and best available damage cost approach.

19
20 Q. WHAT DOES DR. SMITH ASSERT ABOUT THE COMPANY’S EFFORT TO ADDRESS
21 UNCERTAINTY?

22 A. Dr. Smith asserts that the IWG methodology does not reasonably address the
23 inherent uncertainty in estimating climate change damages over 300 years, and
24 includes speculative assumptions (Smith Rebuttal, page 5). I agree that there
25 are massive uncertainties embedded in the SCC calculation, which I discussed

¹⁸ *ORDER ESTABLISHING ENVIRONMENTAL COST VALUES*. In the Matter of the Quantification of Environmental Costs Pursuant to Laws of Minnesota 1993, Chapter 356, Section 3. Docket No. E-999/CI-93-583. January 3, 1997, page 14.

¹⁹ See also Hanemann Rebuttal, page 39..

1 in detail in my testimony (Martin Direct, pages 30-47). These uncertainties
2 make it inappropriate to adopt a single falsely precise point estimate for
3 Commission decisions, or even four falsely precise point estimates such as
4 Drs. Polasky and Hanemann recommend. However, since the Commission
5 has mandated the use of a damage cost rather than a regulatory cost approach,
6 I believe that the IWG's methodology while far from perfect is the best
7 available damage cost approach to use as a starting point. The damage cost
8 approach proposed by Dr. Smith is also subject to uncertainty, and contains
9 different but equally subjective policy judgments.

10
11 Q. WHAT DOES DR. SMITH ASSERT ABOUT THE LEVEL OF RISK TOLERANCE
12 REFLECTED IN THE COMPANY'S PROPOSED RANGE?

13 A. Dr. Smith asserts that the Company is not using the term "risk tolerance" in
14 the manner conventionally used in decision theory (Smith Rebuttal, page 7).
15 The Company specifically defined our proposed risk tolerance criterion:
16 tolerance for the risk that the Commission's CO₂ environmental cost range
17 does not contain the actual value of future climate damages as predicted by
18 the IAMs (Martin Direct, page 56).

19
20 The disaggregated IAM predictions range from -\$29 per metric ton at the 1st
21 percentile, to \$949 per metric ton at the 99th percentile, for emission year
22 2020.²⁰ To the extent the unknown future value of climate damages lies
23 somewhere in this range, a Commission with extremely low risk tolerance
24 could adopt those two values, which would exclude only the values below the
25 1st percentile and above the 99th percentile values and thus have a very high
26 probability of including the "correct" value. As discussed above, this would

²⁰ July 2015 TSD (Exhibit ____ (NFM-2), Schedule 1). See appendix tables A2 to A4 on pages 18-19.

1 not be practicable or useful for Commission decisions.

2
3 The Company's initial range considers the full range of IAM predictions, but
4 excludes the estimates below the 25th percentile at 5 percent discount rate and
5 above the 75th percentile at 2.5 percent discount rate. This excludes about one
6 fourth of all the SCC predictions for a given emission year and retains three
7 fourths (Martin Direct, pages 62-63). The selection of these percentiles, and
8 their corresponding level of risk tolerance, are policy judgments as discussed
9 above. We believe creating an initial range that includes three fourths of the
10 SCC predictions, and then narrowing this range in a way that excludes more
11 low than high SCC predictions, represents an appropriate balance of risk
12 tolerance and practicability.

13
14 Q. DOES DR. SMITH ADVOCATE A DIFFERENT RISK TOLERANCE?

15 A. Dr. Smith advocates not different percentiles or a wider range, but a low and
16 tight range of \$1.62 to \$5.14 per net metric ton that results from her subjective
17 alternate framing assumptions. If the Commission decides retaining the IWG's
18 framing assumptions (global damages, three discount rates, modeling horizon
19 to 2300, and "last ton" modeling) is appropriate, Dr. Smith's range would
20 imply extremely high risk tolerance, since so many of the IAM estimates of
21 global damages lie above \$5.14 per metric ton.

22
23 Q. WHY DOES DR. SMITH BELIEVE THE COMPANY'S RANGE DOES NOT MEET THE
24 CRITERION OF PRACTICABILITY?

25 A. Dr. Smith suggests that the Company's definition of "practicable" means a
26 range of values that will lead to integrated resource planning analyses that do
27 not leave the decision entirely dependent on which end of the range is

1 assumed, and notes that the huge range in IAM predictions (from negative
2 values to over \$900 per ton) means that some method is needed to define a
3 reasonable, narrower range (Smith Rebuttal, page 9). I agree with this
4 characterization.

5
6 Dr. Smith however asserts that our approach is *ad hoc* in that it meets an
7 unspecified degree of risk tolerance, and in that other Parties may have a
8 different sense of how narrow a range is practicable and how much of the full
9 range of IWG estimates they are prepared to ignore (Smith Rebuttal, page 9). I
10 disagree that our approach meets an unspecified degree of risk tolerance. We
11 specified that our initial range excludes approximately one fourth of the
12 450,000 SCC estimates for a given emission year, meaning there is an
13 approximately 25% risk that it does not contain the unknown value of future
14 climate damages, and that equally weighting discount rates makes the range
15 narrower and the risk tolerance higher – i.e., more IAM predictions are
16 excluded – but that this step is risk averse in that it excludes more low values
17 than high (Martin Direct, pages 62-64). I agree, however, that Dr. Smith and
18 other witnesses may have a different sense of how narrow a range is
19 practicable and how much of the full range of IWG estimates they are
20 prepared to ignore. Dr. Smith appears to view a very narrow range (\$1.62 to
21 \$5.14) as practicable. Other witnesses prefer a wider range, representing much
22 lower risk tolerance, which however appears less practicable.

23 24 **V. RESPONSE TO DR. POLASKY**

25
26 Q. WHAT DOES DR. POLASKY SAY ABOUT USE OF A SINGLE POINT ESTIMATE?

27 A. Dr. Polasky argues that the SCC is inherently uncertain, but that “ultimately, in

1 a particular case it will be necessary to decide on a single estimate for the
2 SCC” (Polasky Rebuttal, page 34). I agree that the SCC is uncertain, but
3 disagree that a single estimate is necessary. In fact, the relevant statute
4 mandates,²¹ and the Commission since the 1990s has used, *ranges* rather than
5 single estimates. In addition, I have argued that any single estimate would raise
6 problems of false precision that are problematic for integrated resource
7 planning. The Commission should adopt a range and give each end of the
8 range equal weight in resource planning sensitivities.

9
10 Q. WHAT SCC VALUES DOES DR. POLASKY RECOMMEND FOR ADOPTION?

11 A. Dr. Polasky states that “it would also be reasonable for the Commission to
12 adopt the full range of SCC values, across all three discount rates as well as the
13 95th percentile value, for purposes of this proceeding. Having a range of values
14 would provide the Commission with more information, allowing for a central
15 value (3.0 percent discount rate) along with sensitivity values that can be used
16 in planning” (Polasky Rebuttal, page 35). I disagree that the schedule in the
17 TSD executive summaries actually represents a range; it represents four point
18 estimates, each of them statistically flawed for reasons I have discussed. The
19 Commission would not avoid false precision, as Dr. Polasky maintains, if it
20 adopted these point estimates – and *particularly* not if the 3 percent discount
21 rate value is labeled as “central” and privileged over others.

22
23 Q. DR. POLASKY MENTIONS THAT YOU TAKE THE MEAN OF SCC VALUES AT
24 THREE DIFFERENT DISCOUNT RATES. IS THIS CORRECT, AND ON POINT?

25 A. Dr. Polasky states that “when Martin attempts to summarize information

²¹ Minn. Stat. § 216B.2422, subd. 3(a) requires the Commission, “to the extent practicable, quantify and establish a **range** of environmental costs associated with each method of electricity generation” [emphasis added].

1 across the three different discount rates, he uses the mean rather than the
2 median as the preferred measure. I think this is further indication that the
3 mean rather than the median is the more standard approach and one that is
4 more appropriate for the SCC” (Polasky Rebuttal, page 39).

5
6 This is certainly a strained comparison. Dr. Polasky seems to be suggesting
7 that if the mean is used in one case, it must be appropriate in every case.
8 However, Dr. Polasky ignores that the Company suggested *equally weighting* the
9 SCC values at different discount rates. While I grant that mathematically
10 speaking this is the same as averaging those values, qualitatively it is different
11 and has a different justification. Equally weighting discount rates is an attempt
12 to remain agnostic on an issue that “raises highly contested and exceedingly
13 difficult questions of science, economics, philosophy, and law” about which
14 there is no consensus.²² Even if one ignores this important difference and
15 grants that mathematically it is the same, averaging three values at each end of
16 a range seems sufficiently different from averaging 150,000 values in a non-
17 normal probability distribution, that one could use averaging in one case
18 without this being taken as an endorsement of averaging in every case.

19
20 Q. DOES DR. POLASKY ARGUE FOR MORE OR FEWER CO₂ VALUES?

21 A. Dr. Polasky appears to grant that a large number of values would not be
22 practicable: “It is true that no single measure will capture all of the
23 information in the probability distribution... but there is a tradeoff between
24 more information and practicality. In the extreme, we could require the
25 utilities to incorporate all 150,000 outcomes into their resource planning
26 decisions, but that would be ridiculous” (Polasky Rebuttal, page 40). I agree

²² February 2010 TSD. Attached to my Direct Testimony as Exhibit ____ (NFM-1), Schedule 6. Page 17.

1 that a single value will not capture the variability, and that requiring utilities to
2 run 150,000 SCC sensitivities would be ridiculous.

3
4 His concluding sentence, however – “The downside of more information is
5 that a range of values provides less guidance for resource planners than does a
6 single value” (Polasky Rebuttal, page 40) – does not in any way follow. A
7 range of values provides *more* information for resource planning than a single
8 value, not less. A single value (whether the mean, median or another) suggests
9 the value of climate damages is known with precision, which it is not, and
10 drives resource planning in a direction that may not be optimal from a societal
11 perspective if that single value turns out to be too low or too high. A range of
12 values provides more information for resource planning sensitivities, used to
13 ensure that a proposed resource plan is robust under various assumptions.

14 15 **VI. RESPONSE TO DR. HANEMANN**

16
17 Q. WHY DOES DR. HANEMANN ASSERT THE IWG’S USE OF STANFORD EMF-22
18 SCENARIOS ADEQUATELY CAPTURES FUTURE EMISSIONS?

19 A. Dr. Hanemann notes that the IWG used five Stanford EMF-22
20 socioeconomic and emission scenarios as standardized inputs to the IAMs,
21 treating all as equally likely to occur and using its own assumptions to extend
22 these from 2100 to 2300 (Hanemann Rebuttal, page 18). These emission
23 forecasts depend on assumptions regarding the CO₂ intensity of technologies
24 that could prove inaccurate, considering the long timeframe at issue. One of
25 the five (the “stabilization” scenario) assumes coordinated global action to
26 contain atmospheric CO₂ concentrations at 550 ppm, while the rest are
27 “business-as-usual” scenarios assuming no coordinated global action. Dr.

1 Hanemann asserts that because the IWG gave 20 percent weight to the
2 stabilization scenario that assumes coordinated global action, the IWG has in
3 fact addressed societal response to climate change (Hanemann Rebuttal, page
4 23). This is not the same as endogenous modeling of technological change. It
5 merely means 30,000 of the 150,000 results for a given emission year and
6 discount rate assume global coordinated action, while the other 120,000 do
7 not. All EMF-22 emission trajectories are still exogenous, up-front inputs that
8 do not change in response to the temperature change and damages the IAMs
9 predict that future societies experience. In fact, Dr. Hanemann also voices
10 skepticism that future societies will in fact act to enhance mitigation efforts,
11 citing the challenges of the UNFCCC negotiations among 196 nations
12 (Hanemann Rebuttal, page 26), suggesting he is not fully convinced of his own
13 assertion that the IAMs capture societal response.

14
15 Q. WHAT DOES DR. HANEMANN SAY REGARDING EMISSIONS LEAKAGE?

16 A. Dr. Hanemann argues that the Commission should not account for leakage
17 when applying its CO₂ environmental costs range because the Commission
18 lacks responsibility for or jurisdiction over utilities outside Minnesota, and
19 “there is no reason to modify its assessment of the environmental cost of
20 emissions based on what may or may not happen in other jurisdictions”
21 (Hanemann Rebuttal, pages 30-31). I would draw the opposite conclusion. If
22 the Commission is trying to estimate the benefits (avoided climate damages)
23 of reducing emissions from the Minnesota emission sources over which it has
24 jurisdiction, the Commission may overestimate that benefit if it ignores the
25 possibility that its action may create offsetting emission increases outside its
26 jurisdiction. However, this issue is outside the scope of the present
27 proceeding, which only seeks to determine what the damage values should be,

1 not the emissions to which they will be applied. The Commission could
2 consider using leakage adjustment factors in other proceedings in which the
3 CO₂ environmental cost values are used (Martin Rebuttal, pages 52-53).

4
5 Q. WHAT SCC VALUES DOES DR. HANEMANN RECOMMEND?

6 A. Dr. Hanemann's recommendation was unclear in his Direct Testimony, where
7 he asserted that the Federal SCC is a reasonable and best available measure
8 but not which value(s) he recommends. In his Rebuttal Testimony Dr.
9 Hanemann is clearer, stating that for a point estimate he would recommend
10 the average across IAMs at 3 percent discount rate (\$36 for 2015 and \$42 for
11 2020, from the July 2015 TSD), and for a range he would recommend the
12 average across IAMs at 2.5, 3 and 5 percent discount rates (Hanemann
13 Rebuttal, page 87). Thus his primary recommendation appears to be a point
14 estimate, or three point estimates, but does not appear to include the 95th
15 percentile value. He then adds that "if one viewed the SCC through the lens of
16 risk management," the 95th percentile value (\$105 for 2015 and \$123 for 2020,
17 from the July 2015 TSD) "would be a relevant consideration" (Hanemann
18 Rebuttal, page 88).

19
20 Q. DO YOU AGREE WITH THIS RECOMMENDATION?

21 A. I do not. Any falsely precise point estimate – the mean, median, or any other
22 single value – is inappropriate for integrated resource planning. The three
23 point estimates constituting the average across IAMs at 2.5, 3 and 5 percent
24 discount rates are inappropriate because they are point estimates, and because
25 they are averages of a non-normal probability distribution. The 95th percentile
26 value is inappropriate because it only accounts for one direction in which the
27 IAMs fail to model important climate-economy dynamics.

1 **VII. RESPONSE TO DR. MENDELSON**

2
3 Q. DR. MENDELSON ASSERTS THAT YOU HAVE BEEN “WORKING FOR THE
4 PRIVATE SECTOR FOR 15 YEARS.” IS THIS ON POINT?

5 A. I am unclear on the purpose of this statement (Mendelsohn Rebuttal, page 8).
6 My resume, attached as Exhibit ____ (NFM-1), Schedule 1, demonstrates my
7 experience as a policy witness in this proceeding. This includes work for
8 Winrock International, a non-profit organization internationally renowned for
9 its research in climate science and carbon mitigation through forestry,
10 agriculture and land use, where I conducted GHG assessments in many of the
11 same areas of research as Dr. Mendelsohn’s own; for the American Carbon
12 Registry, writing protocols to quantify carbon sequestration and GHG
13 avoidance for both the voluntary carbon market and the California cap-and-
14 trade market; and for Xcel Energy, focusing on carbon policy including both
15 the national cap-and-trade legislation considered in the late 2000’s and the
16 Clean Air Act regulation of GHG emissions that is moving forward today.

17
18 Q. WHAT DOES DR. MENDELSON SAY REGARDING A RANGE VS. A SINGLE
19 VALUE?

20 A. Dr. Mendelsohn asserts that the Company’s “desire to have a range of values
21 and not a single value makes the process of using the SCC completely arbitrary
22 and capricious which violates another of his own principles about
23 transparency” (Mendelsohn Rebuttal, pages 8-9). It is unclear from this
24 statement if Dr. Mendelsohn agrees or disagrees with the need for a range
25 rather than a single value, but I will assume he agrees a range is needed, since
26 he himself has proposed three ranges depending on the assumed equilibrium
27 climate sensitivity (Mendelsohn Direct, pages 2 and 15). At any rate, the

1 relevant statute requires a range. I disagree that our derivation of a range
2 makes the Company's approach arbitrary, capricious, or non-transparent. Our
3 selection of percentiles was explicit and non-arbitrary, and our methods were
4 transparently described in my Direct Testimony and accompanying Schedules.
5 Unlike Dr. Mendelsohn, I provided with my Direct Testimony all the raw
6 data, coding and spreadsheets necessary to examine, replicate or revise our
7 methods if other Parties wish to do so.

8 9 **VIII. RESPONSE TO DR. BEZDEK**

10
11 Q. ARE YOU SUGGESTING THAT MINNESOTA ADOPT NEGATIVE SCC VALUES?

12 A. Dr. Bezdek points out that some of the IAM predictions are negative and
13 inquires whether I am "thus suggesting that Minnesota use negative SCC
14 values" (Bezdek Rebuttal, Exhibit 1, page 44). This is true for FUND, in some
15 regions, in the near term, due primarily to enhanced agricultural productivity
16 and reduced heating demand. However, the primary developer of FUND (Dr.
17 Tol, a Peabody witness) has noted that "these benefits are rapidly outweighed
18 by the harm that occurs as warming becomes more pronounced, and are
19 probably gone with a 2°C rise. Incremental impacts turn negative once
20 temperatures rise by about 1°C," and some regions of the world may
21 experience only damages.²³

22
23 The Company is not proposing the adoption of negative values. The negative
24 values included in the left tail of the SCC distributions fall below the 25th
25 percentile at 5 percent discount rate that was the low bound of our initial

²³ Richard Tol, "Bogus Prophecies of Doom Will Not Fix the Climate," Financial Times, March 31, 2014.
<http://www.ft.com/cms/s/0/e8d011fa-b8b5-11e3-835e-00144feabdc0.html#axzz3k7WJmOGD>.

1 range. We are proposing a range from \$12.13 to \$41.40 (2014 dollars per short
2 ton) for emission year 2020, and corresponding ranges for other years as
3 shown in Table 2 of my Rebuttal Testimony (page 8) and in
4 Exhibit___(NFM-2), Schedule 2 (2014 dollars per short ton) and
5 Exhibit___(NFM-2), Schedule 3 (nominal dollars per short ton).

6
7 Q. COULD THE COMPANY PROVIDE SCC VALUES AT 7 PERCENT DISCOUNT RATE
8 WITHOUT NEW MODELING?

9 A. Dr. Bezdek asserts that the Company could calculate values at 7 percent
10 discount rate without new modeling, and offers to provide results of modeling
11 by others at this discount rate (Bezdek Rebuttal, Exhibit 1, page 46). To
12 clarify, I did not intend to suggest that no such modeling exists. Rather – since
13 the IWG’s modeling results were our starting point, and the IWG provided
14 results only for 2.5, 3 and 5 percent discount rates – we could derive our range
15 only for those discount rates without modeling. If in the future the IWG
16 prepares SCC estimates at 7 percent (or other) discount rates, our range can be
17 updated by incorporating those IAM outputs into the initial distributions and
18 then equally weighting them with the current discount rates.

19
20 Q. WHAT RANGE DOES DR. BEZDEK PROPOSE FOR COMMISSION ADOPTION?

21 A. Dr. Bezdek suggests that the Commission could either retain the values set in
22 1996, which he updates for inflation, arriving at values close to the
23 Commission’s current values;²⁴ or could adopt values lower than the 1996
24 values “in the range of about \$0.20 to \$2.00 per ton, or lower” (Bezdek
25 Rebuttal, Exhibit 1, page 48). I am unclear how to reconcile this
26 recommendation with that of another Peabody witness, Dr. Mendelsohn, who

²⁴ Notice of Updated Environmental Externality Values. *In the Matter of the Investigation into Environmental and Socioeconomic Costs under Minnesota Stat. Section 216 B 2422, Subd. 3.* May 27, 2015.

1 recommends a range from \$4 to \$6 (Mendelsohn Direct, page 2 and 15) and
2 other ranges at other equilibrium climate sensitivity assumptions. At any rate, I
3 do not believe the ranges recommended by any of Peabody's witnesses meet
4 the Company's proposed standard of review criteria.

5 6 IX. CONCLUSION

7
8 Q. PLEASE SUMMARIZE YOUR SURREBUTTAL TESTIMONY.

9 A. My testimony responds to other witnesses on the following points:

- 10 • Why the Company opposes adoption of the four Federal SCC point
11 estimates;
- 12 • Why we used the IWG's modeling outputs, despite acknowledged flaws,
13 believing these provide a reasonable and best available starting point
14 considering the Commission's requirement for a damage cost approach;
- 15 • Why we oppose adoption of the mean, median, 95th percentile, or any other
16 falsely precise point estimate;
- 17 • Why the 25th and 75th percentiles represent an appropriate balance of
18 uncertainty, risk tolerance and practicability, and why other percentiles
19 would represent lower risk tolerance but merely point in opposite directions
20 for resource planning and therefore be less practicable;
- 21 • Why equally weighting the IWG's three discount rates is an appropriate
22 response to this unresolved and highly contentious element of the SCC
23 calculation, and enables the Commission to adopt just two values (low and
24 high) as it has done since the 1990s; and
- 25 • Why the Company's methods are fully transparent, replicable and
26 updateable.

1 The Company believes the IWG’s modeling outputs constitute a reasonable
2 and best available starting point, based on the work of credible experts in
3 climate science and economics, for the Commission’s CO₂ environmental cost
4 range. Considering the significant influence these values may have on
5 integrated resource planning, it is crucial to avoid false precision by adopting a
6 range rather than single point estimates, and to give equal weight to both ends
7 of the range in resource planning sensitivities. We have proposed a range that
8 is practicable, reasonably risk-averse, transparent and easy to update in the
9 future if the IWG publishes updates to the Federal SCC.

10
11 A theme throughout this testimony is that estimating the SCC is only partly a
12 matter of climate science; it is also strongly driven by inherently subjective
13 policy judgments that have no one “right” answer. Some witnesses have
14 proposed alternate policy judgments, which are in general no less subjective
15 than the IWG’s; the applicable statute is silent on these matters, and
16 Commission precedent is mixed. However, the Commission retains its
17 prerogative to make policy judgments that may align with, or differ from, the
18 policy judgments of the IWG. In using the IWG’s modeling outputs as our
19 basis, the Company implicitly accepted many of the IWG’s policy judgments;
20 however we acknowledged that the Commission could choose differently (e.g.,
21 a narrower geographic scope of damage assessment, fewer discount rates,
22 etc.), and indicated how the Company’s range could be adjusted accordingly.

23
24 Q. DO YOU STAND BY YOUR PROPOSED RANGE?

25 A. Yes. The Company’s approach is reasonable and the best available measure to
26 determine the environmental cost of CO₂ under Minn. Stat. §216B.2422. Our
27 proposal constructively addresses the significant uncertainty inherent in

1 estimating the SCC while paving the way for Minnesota to show leadership
2 with respect to global climate change. It balances, better than the testimony of
3 any other witness, eight standard of review criteria the Company proposes the
4 Commission should use in determining a CO₂ environmental costs range.

5

6 Q. DOES THIS CONCLUDE YOUR SURREBUTTAL TESTIMONY?

7 A. Yes.

CERTIFICATE OF SERVICE

I, James Erickson, hereby certify that I have this day served copies of the foregoing document on the attached list of persons.

xx by depositing a true and correct copy thereof, properly enveloped with postage paid in the United States mail at Minneapolis, Minnesota; or

xx by electronic filing.

MPUC Docket No. E999/CI-14-643

Dated this 10th day of September 2015.

/s/

James Erickson

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