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ASSESSMENT OF APPROACHES TO UPDATING THE SOCIAL COST OF CARBON: PHASE 1 INTERIM REPORT ON A NEAR-TERM UPDATE

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Via WebEx

Maureen Cropper (Co-chair)
University of Maryland

Richard Newell (Co-chair)
Duke University

Steven Rose
Electric Power Research Institute

Chris Forest
Pennsylvania State University

Division of Behavioral and Social Sciences and Education

Board on Environmental Change and Society

Committee Roster

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RICHARD G. NEWELL (Co-chair)	Duke University
MYLES ALLEN	University of Oxford
MAXIMILIAN AUFFHAMMER	University of California, Berkeley
CHRIS E. FOREST	The Pennsylvania State University
INEZ Y. FUNG	University of California, Berkeley
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HENRY D. JACOBY	Massachusetts Institute of Technology
ROBERT KOPP	Rutgers University
WILLIAM PIZER	Duke University
STEVEN ROSE	Electric Power Research Institute
RICHARD SCHMALENSEE	Massachusetts Institute of Technology
JOHN P. WEYANT	Stanford University

JENNIFER HEIMBERG, Study Director
CASEY J. WICHMAN, Technical Consultant, Resources for the Future
MARY GHITELMAN, Program Assistant

Committee expertise spans the disciplines relevant to the study task: environmental economics, climate science, energy economics, integrated assessment modeling, decision science, climate impacts, statistical modeling, and public policy and regulation.

Report Reviewers

Report review was overseen by: **Elisabeth M. Drake** (Massachusetts Institute of Technology) and **Charles F. Manski** (Northwestern University)

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JAMES (JAE) EDMONDS	Pacific Northwest National Laboratory
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Study Origin and Description

The Interagency Working Group (IWG) on the social cost of carbon (SCC) requested this study to inform its future revisions of SCC estimates.

Phase 1 was to be completed within 6 months of the start of the study. Phase 2 encompasses a wider review of the SCC, with a report expected early 2017.

PHASE 1:

The committee will assess the technical merits and challenges of a ***narrowly focused update*** to the SCC estimates and ***make a recommendation on whether the IWG should update*** the SCC estimates prior to Phase 2 committee recommendations related to a more comprehensive update based on its review of the science related to the topics covered in Phase 2.

Phase 1 Task

Consider whether a near-term update to the SCC estimates is warranted based on:

1) Updating the probability distribution for equilibrium climate sensitivity (ECS) to reflect the IPCC Fifth Assessment Report rather than Fourth Assessment Report

2) Recalibrating the distributional form for the ECS, which the IWG based on the Roe and Baker (2007) distribution

3) Enhancing the qualitative characterization of uncertainties associated with the current SCC estimates to increase their transparency when used in regulatory impact analyses

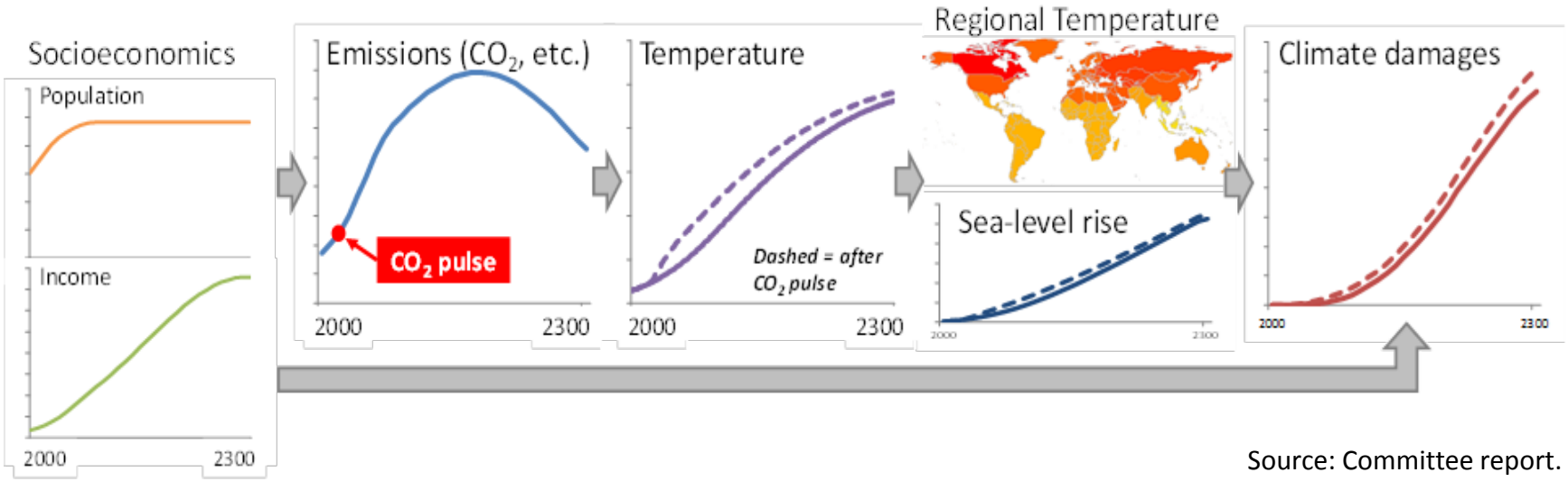
What is the social cost of carbon?

Social cost of carbon (SCC): the cost to society of adding 1 ton of CO_2 into the atmosphere in a particular year (in US dollars)

Intended to measure the monetized value of the net impact of an additional ton of CO_2 on (but not limited to):

- Changes in net agricultural productivity
- Energy use
- Human health
- Property damage from increased flood risk
- Other impacts

How is the SCC estimated?



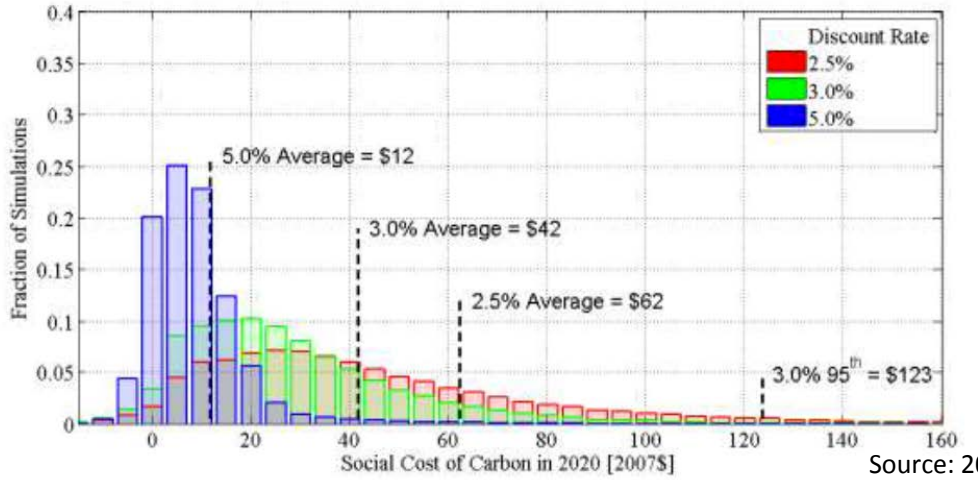
Source: Committee report.

- Future population and GDP paths imply a future baseline path of CO_2 emissions
- Path of CO_2 emissions leads to predictions of mean global temperature
- Augment the emissions path with a CO_2 pulse
- Trace temperature path into impacts and damages--with and without the pulse
- SCC is the per-ton difference in present value of damages due to the pulse

How is the SCC estimated?

The IWG used:

- Three integrated assessment models (IAMs)
  - DICE, FUND, and PAGE
- Five socioeconomic-emissions scenarios
- One distribution for equilibrium climate sensitivity (ECS)
- Three different discount rates (2.5%, 3%, 5%)
- The official SCC for a given year and discount rate is an average of 150,000 estimates (3 models x 5 socioeconomic scenarios x 10,000 random draws over uncertain parameters in each model), plus the 95th percentile using a 3% discount rate

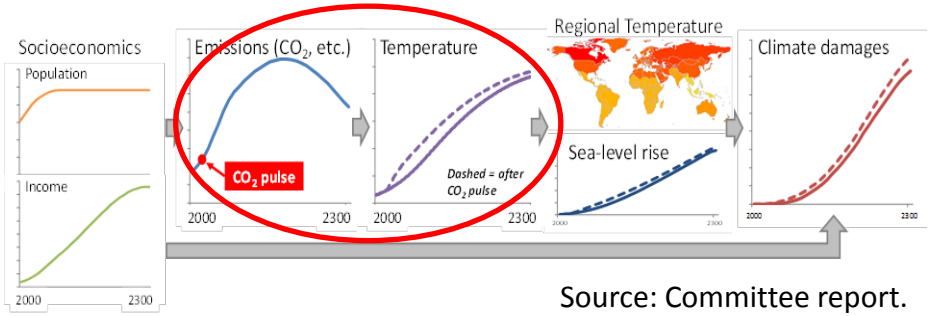


Source: 2015 IWG Technical Support Document.

Equilibrium climate sensitivity (ECS)

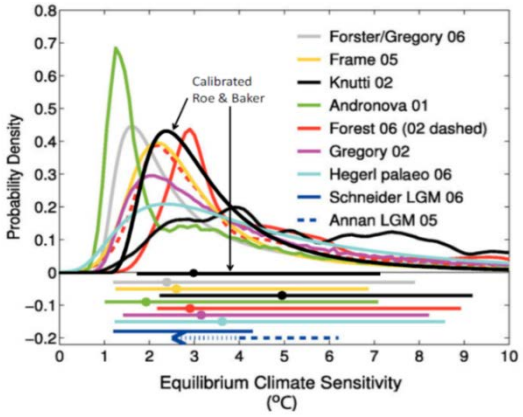
ECS is the long-term response of global mean temperature to an instantaneous doubling of CO_2 concentrations from preindustrial levels

ECS is one input to the Integrated Assessment Models (IAMs) that link emissions to temperature. The range of ECS values is described by a probability distribution.



Source: Committee report.

The current distribution used by the IWG is the one proposed by Roe and Baker in 2007 calibrated to the IPCC Fourth Assessment Report (2007).



Source: 2010 IWG Technical Support Document.

Committee Consensus

- The committee recommends against a near-term update to the representation of the climate system in the SCC modeling framework based on a single parameter
  - Revising the equilibrium climate sensitivity (ECS) alone within the current framework may not significantly improve SCC estimates
- A common climate module could be developed that would be consistent with climate parameters on shorter timescales relevant to SCC
- A discussion of uncertainties underlying SCC estimates should be included in the executive summary of IWG technical support documents
- It is desirable to include a balanced presentation of uncertainty in SCC estimates
- Separating the role of discount rates from other sources of SCC variability is important

Study approach

Considerations in evaluating a near-term update to the SCC:

- Would an update improve the representation of the response of temperature to emissions relative to state-of-the art models?
- Would an ECS update alone improve the overall reliability of the SCC?
- What are alternative options for climate system representation in modeling the SCC?
- What is the opportunity cost of near-term efforts in terms of potential longer-term improvements?
- Are the Committee's Phase 1 recommendations consistent with possible Phase 2 conclusions and recommendations?

Conclusions regarding updating ECS within current IWG framework

Conclusion 1:

ECS is only one parameter affecting the SCC and each of the SCC IAMs embodies different representations of the climate system. Therefore, updating ECS alone within the current SCC framework may not significantly improve the SCC estimates.

Conclusion 2:

ECS is less relevant than TCR, TCRE, and IPT in characterizing the climate system response on timescales less than a century. Thus, simply updating the ECS distribution without assessing the impact on other metrics may not result in an improved estimate of the SCC.

Various climate response metrics

ECS (Equilibrium climate sensitivity)
the long-term equilibrium temperature change from doubling CO_2 concentrations, which takes many centuries to be realized

TCR (Transient climate response)
the temperature change at the time of doubling (year 70) from doubling CO_2 concentrations along a path that rises 1% per year

TCRE (Transient climate response to emissions)
the ratio of TCR to cumulative CO_2 emissions at the time of doubling

IPT (Initial pulse-adjustment timescale)
the time at which peak temperature change occurs in response to a pulse of CO_2 emissions, which is about 1 decade after emission

The report describes experiments for assessing a climate model against these metrics

Recommendation 1: Regarding updating the ECS in current IWG framework

- The committee recommends against a near-term update to the SCC based simply on a recalibration of the probability distribution of the ECS to reflect the recent consensus statement in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

- Consequently, the committee also recommends against a near-term change in the distributional form of the ECS.

A common climate "module"

The IWG could adopt or develop a common "module" that represents the relationship between CO_2 emissions and global mean surface temperature

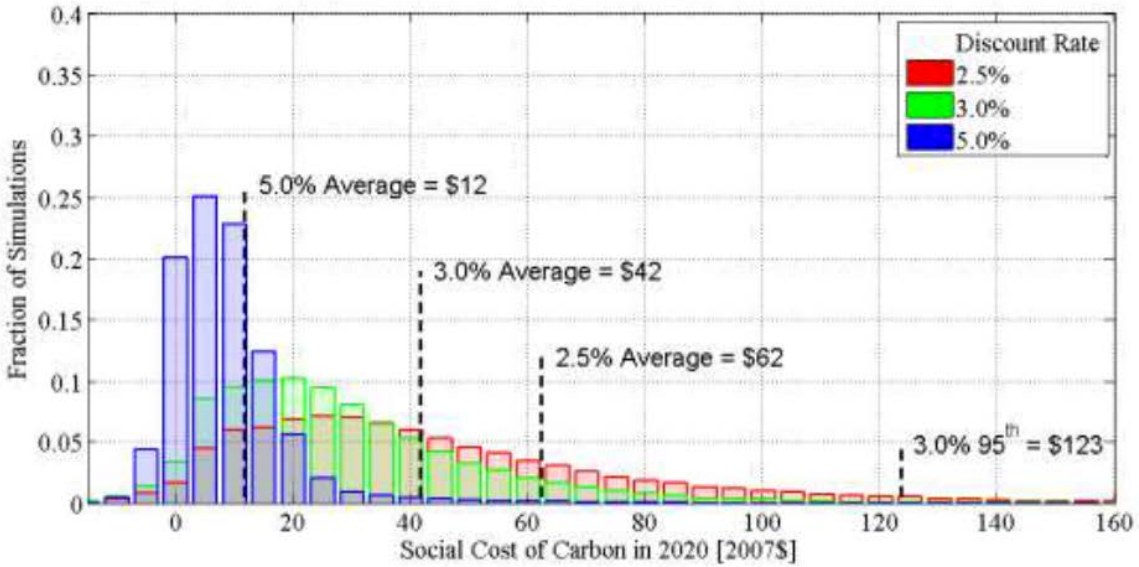
- Would provide better experimental control over characterization of climate system response and uncertainty
- Should be **consistent** with best available scientific evidence, and assessed based on its response to a pulse of emissions and to long-term forcing trajectories (e.g., those designed to assess TCR and TCRE, as well as high- and low-emissions baseline trajectories)
- Should strive for **simplicity** and **transparency**, so that the central tendency and range of uncertainty in its behavior are readily understood, are reproducible, and are amenable to continuous improvement over time
- Should consider the possible implications of this choice for the assessment of impacts of other, non-CO_2 greenhouse gases

Current treatment of uncertainty

Frequency distributions of results are presented for each discount rate

- Calculated by taking 10,000 draws from distribution of the ECS and other random parameters for each of the three SCC IAMs
  - more than 60 random parameters in FUND and more than 50 in PAGE
- Repeated for each of five socioeconomic-emissions scenarios

Figure below shows the resulting distributions of SCC estimates for each of the three discount rates (2.5%, 3%, 5%) for the year 2020



Source: 2015 IWG Technical Support Document.

Conclusions regarding uncertainty

Conclusion 3:

The current technical support document (TSD) describes the factors on which the SCC is conditioned (such as the discount rate) and also makes explicit the inputs that are varied. However, it does not detail all sources of model-specific uncertainty in the SCC IAMs.

Conclusion 4:

Multiple runs from three models provide a frequency distribution of SCC estimates based on varying a number of inputs. This set of estimates does not fully characterize uncertainty about the SCC.

Conclusion 5:

It is important to separate the impact of the discount rate from other sources of variability. A balanced presentation of uncertainty includes both low and high values conditioned on each discount rate.

Recommendation 2: Treatment of uncertainty in the IWG analysis

- Continue to describe sources of uncertainty and to presents frequency distributions of results

- Enhance description of uncertain parameters in PAGE and FUND models in an appendix to the IWG's technical support document (TSD)

Recommendation 3: Sources of uncertainty, including those omitted

IWG should include a section "Treatment of Uncertainty" in each TSD to provide a unified discussion of:

- How various types of uncertainty were handled in estimating the SCC, for example:
  - Model-specific uncertainties
  - Climate damages, their valuation, potential catastrophic outcomes
  - Weighting of the socioeconomic-emissions scenarios
- Sources of uncertainty that are not captured

Current reporting of results in the Executive Summary of TSD

Discount Rate Year	5.0% Avg	3.0% Avg	2.5% Avg	3.0% 95th
2010	10	31	50	86
2015	11	36	56	105
2020	12	42	62	123
2025	14	46	68	138
2030	16	50	73	152
2035	18	55	78	168
2040	21	60	84	183
2045	23	64	89	197
2050	26	69	95	212

Source: 2015 IWG Technical Support Document

Recommendation 4: Presentation of results in the executive summary of the TSD

The executive summary should provide guidance for interpreting and using SCC estimates in regulatory impact analyses:

- SCC estimates based on a given discount rate should be combined with cost/benefit estimates using consistent discount rates
- Uncertainty ranges should include uncertainty from the frequency distribution of SCC estimates, including symmetric high and low values
- To facilitate this consider using the following . . . .

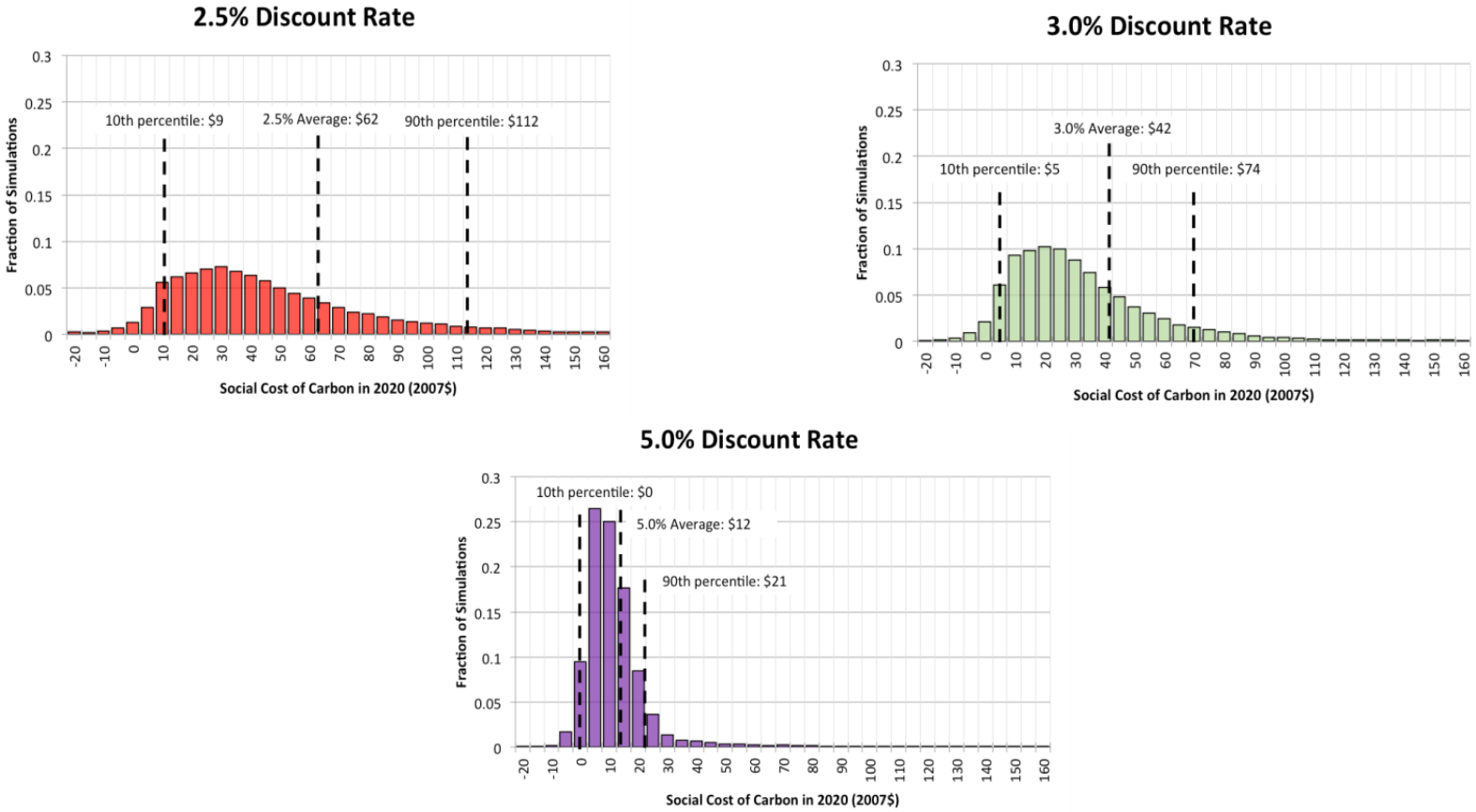
Example of possible table of results in TSD executive summary

TABLE 5-1: An Example Table of SCC Estimates

Year	Discount Rate								
	5.0%			3.0%			2.5%		
	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High
2020	--	--	--	--	--	--	--	--	--
2025	--	--	--	--	--	--	--	--	--
…									
2050	--	--	--	--	--	--	--	--	--

Source: Committee report.

Example of possible figures of results in TSD Executive Summary



Source: Committee report.

Summary

- The committee recommends against a near-term update to the SCC modeling framework
  - Revising the ECS or its distribution may not by itself improve SCC estimates
- A common climate module could be developed consistent with climate parameters on shorter timescales
- Further discussion of uncertainties included and excluded from the IWG framework is warranted
- The executive summary to the IWG's TSD should include a balanced presentation of variability in SCC estimates and distinguish discount rates from other sources of variability