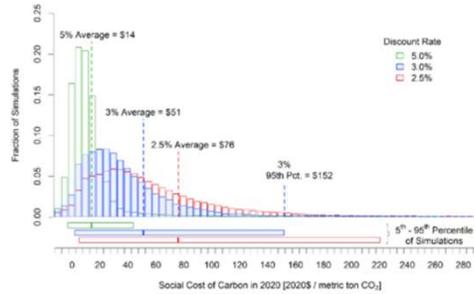


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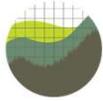
## The Social Cost of Carbon



Peter H Howard, PhD  
Economics Director

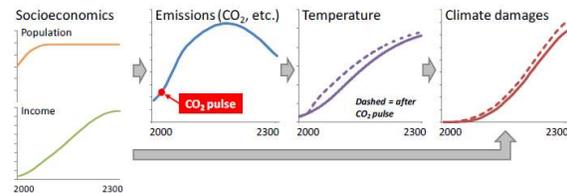
Institute for Policy Integrity at New York University School of Law

Sources: Interagency Working Group (2021)



## What Is the Social Cost of Carbon (SCC)?

- SCC is the marginal external cost of CO<sub>2</sub> emissions
- Calculated using an integrated assessment model (IAM)
  - Scenarios: population, emissions, and GDP: EMF-22
  - Simple climate model: IAMs and IPCC
  - Damage function(s): IAMs
  - Discount rate: 2.5%, 3%, & 5% (agencies can consider lower)

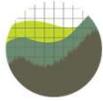


*Steps in climate-economic models that transform a unit of emissions into a monetary impact*

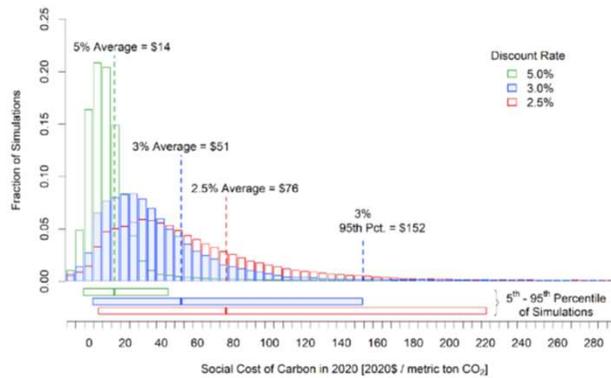
Source: Electric Power Research Institute (Rose et al., 2014)

2

- 1) The social cost of carbon (SCC) is the marginal cost of one ton of carbon emissions
  - a) In other words, the social cost of carbon (SCC) is an estimate of the total cost of damage done by each ton of carbon dioxide (over approximately 300 years) that is emitted into the air
- 2) IWG
  - a) Select three most cited IAMs, including one for which Nordhaus won the Nobel Prize in Economics
  - b) Replace scenarios with 5 scenarios from Stanford Energy Modeling Forum EMF-22 that span the emissions space (the average is roughly equivalent with a current policy scenario)
  - c) Replace equilibrium climate sensitivity parameter with distribution calibrated to the 4<sup>th</sup> IPCC assessment
  - d) Select three consumption discount rates: 2.5%, 3%, and 5% (low, central, and high)
  - e) Run Monte Carlo simulation taking 10,000 draws for each model-scenario-discount rate combination
  - f) Average SCC across models and scenarios



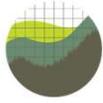
## 2021 Interagency Working Group's SCC Estimates



Sources: Interagency Working Group (2021)

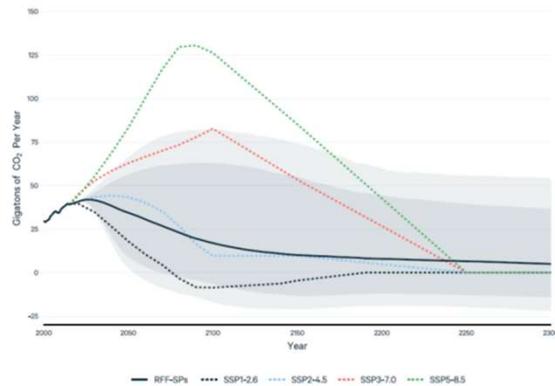
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- 1) Interagency Working Group's central recommended estimate is \$51/ton
- 2) National Academy of Sciences
  - a) NAS (2016) said that the SCC was solid at the time
  - b) NAS (2017) called for an update and improvement in methods



## Scenarios: Emissions

- National Academy of Sciences (2017)
  - Time horizon sufficient to capture most damages ( $\approx 300$  years)
  - Calculate scenario based on likelihood of policies
- Interagency Working Group's scenario is a good approximation
  - New studies better reflect distribution of possibilities

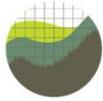


*Estimate of the most-likely emissions path (and its underlying uncertainty) compared to the IPCC's Shared Socioeconomic Pathways*

Source: Resources for the Future (Rennert et al., 2021)

4

- 1) National Academy of Sciences recommended creating a scenario that:
  - a) One: Make long-run projections over 300 years as damages are still significant in the present period after discounting
  - b) Second: Capture the full range of uncertainty, including the uncertainty underlying policy
- 2) The IPCC scenarios generally only project out 100 years with some exceptions going out 300 years
  - a) RFF and others have developed more sophisticated scenarios consistent with NAS recommendations
  - b) Interestingly, they support the average IWG scenario as roughly appropriate
  - c) RFF's model is a better representation of scenario uncertainty

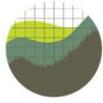


## Climate Model

- Update to most sophisticated simple climate model
- Reflect latest and best climate science in IPCC report
  - IPCC's latest equilibrium climate sensitivity parameter (warming from doubling of CO<sub>2</sub>) is relatively consistent with IWG
  - Improve modeling of short-run warming dynamics
- NAS recommends the FAIR climate model

5

- 1) NAS (2017) made clear that IWG should switch to:
  - a) Improved simple climate model
  - b) Climate model reflects the latest and best science as reflected by the IPCC
- 2) For example:
  - a) The equilibrium climate sensitivity parameter – the amount of warming in the long-run from a doubling of CO<sub>2</sub> emissions – is roughly consistent between the IWG assumption and the latest IPCC report published last year
  - b) Short-term warming parameters also matter
- 3) NAS recommended the FAIR model



## Climate Damages Are Higher Than Previously Thought

- IAM damages are outdated and missing impacts
  - Market impacts (e.g., agriculture)
  - Health and environmental impacts (e.g., wildfires)
  - Environmental and social tipping points (e.g., conflict)
- Improved estimation
  - Big data (Climate Impact Lab)
  - Review and update literature (Resources for the Future)
  - Meta-analysis (Policy Integrity)
  - Survey experts (Policy Integrity)

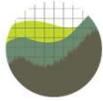
Year	2025	2075	2130
Temperature increase (relative to pre-industrial era)	1.2°C	3°C	5°C
Economic damages (% of global GDP) - Median estimate	-1%	-5%	-10%
Economic damages (trillions of 2019 USD) - Median estimate	-\$1.7	-\$29.8	-\$143.0
Economic damages (% of global GDP) - Mean estimate	-2.2%	-8.50%	-16.10%
Economic damages (trillions of 2019 USD) - Mean estimate	-\$3.8	-\$50.6	-\$230.3
Standard deviation	2.9	7.6	13.3

*2021 Climate Damage Forecasts by Economists Publishing on Climate Change in Top Ranked Economics Journals*

Source: Institute for Policy Integrity (Howard and Sylvan, 2021)

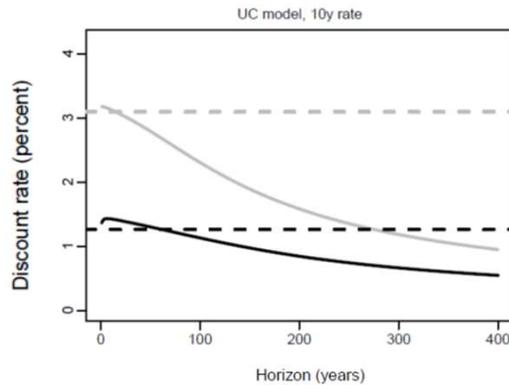
6

- 1) The damage functions underlying the current SCC estimate miss climate impacts and use outdated estimates
  - a) For example, agriculture impacts are too low in IAMs
  - b) Omitted impacts include wildfires, ocean-acidification, inland flooding, conflict and other social impacts, and sophisticated environmental tipping points (and their positive correlation)
  - c) Already captures benefits, like CO2 fertilization in most IAMs
- 2) All new strands of evidence over the last decade point to much higher damages
  - a) For example, experts predict a most likely impact of -5% or -8.5% based on the median and mean, respectively, in a recent 2021 survey
  - b) This is far above older models, which used less sophisticated methods or older data



## Discount rate of 2% or lower

- Substantial new research supports a consumption discount rate
  - High capital rate is not appropriate
- Up-to-date evidence supports 2% or lower
  - Market rates
  - Surveys of economists
  - Recent economic theory

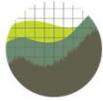


*"Discount rates (real yields) calculated using simulations from UC model...The gray term structure is based on the [10 year] real rate [approximated by 10-year Treasury yield adjusted for inflation] and estimated in 1990, and the black term structure uses the values for 2019."*

Source: Bauer and Rudebusch (2021)

7

- 1) New research points to the consumption discount rate being more appropriate in the climate context
  - a) Circular A-4 allows a lower discount rate in intergenerational problems due to discount rate uncertainty
  - b) Recent extensions of the logic underlying Circular A-4 supports a consumption rate (Li and Pizer, 2021; NAS; Newell)
- 2) Multiple lines of evidence supports a lower discount rate
  - a) Demographic shift leading to lower market discount rate in long-run
    - i. People are living longer, but retiring at the same age, so saving more and pushing down on discount rate
    - ii. Should be expected to continue
  - b) Surveys of economists and discount rate experts support this shift as well
  - c) Improvements in economic theory also support a lower rate than previously

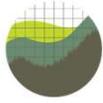


## Recent research points to Higher SCC

- Resources for the Future (RFF) estimate of \$168/ton
  - Improved scenario (RFF)
  - Updated climate model (FAIR)
  - 2% discount rate
  - Outdated damages
- Higher damages will increase the SCC above \$200
- IWG estimate is a lower bound even for 3% rate

8

- 1) Together, these estimates imply a damage estimate that is greater than \$200
- 2) Given the evidence, the current estimate of \$51 should be interpreted as a lower bound even at the 3% discount rate



## Thank You

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