Potential Updates to the Social Costs of Carbon and Other Greenhouse Gases (SC-GHGs)

EPA's draft revised methodology and use of estimates

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March 8, 2023

Crucial time for SC-GHG engagement and dialogue

- EPA released draft new SC-GHG estimates – much higher
- Draft new estimates already being applied
  - e.g., proposed oil and gas CH_4 rule, NEPA draft guidance
- EPRI observes significant technical issues
  - With the draft methodology
  - With SC-GHG use in informing policy
- Impending methodology peer review, but problematic
- Public engagement process unclear
- Scientific due diligence needed, but not happening

- Why is this important?
  - SC-GHGs values being widely considered – federal (regulations, NEPA, more), power dispatch, resource planning, social energy pricing, state regulations, and Canada
  - An extremely challenging topic – massive scope (projecting populations, economies, and earth systems for 300 years)

Scientific due diligence requires

1. Assessing the science
2. Providing transparency
3. Justifying choices
4. Developing a methodology fit for purpose
5. Separating science from policy
6. Establishing robustness and using the estimates properly
7. Successfully completing an appropriate scientific review
8. Engaging the public

Putting science first in creating and using the social cost of carbon , ***The Hill, 11/18/2022***

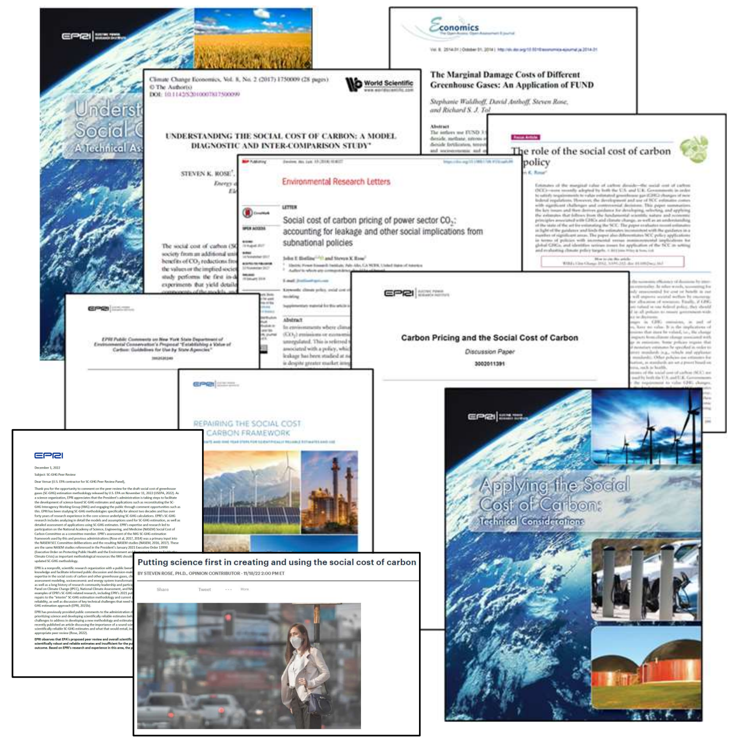
EPRI and the SC-GHGs

EPRI

- A non-advocacy, non-profit, scientific research organization with a public benefit mission
- Strives to advance knowledge and facilitate informed discussion and decision-making

SC-GHG expertise

- S Rose was a member of the National Academies of Sciences, Engineering and Medicine (NASEM) Committee on Assessing Approaches to Updating the Social Cost of Carbon
  - EPRI's research a key input to the NASEM (2016 and 2017) studies
- 20 years of SC-GHG expertise, 50 years of related research
  - Recognized scientific expertise in, among other things, the social cost of carbon and other greenhouse gases, climate scenarios, climate-related risk assessment, integrated assessment modeling, socioeconomic and energy system transformation, and climate policy evaluation
- Long history of research community leadership and participation in, among other things, the Intergovernmental Panel on Climate Change, Energy Modeling Forum, National Climate Assessment, and Task Force on Climate-related Financial Disclosures



Topics

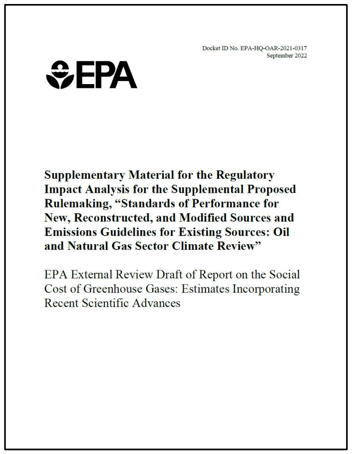
- Technical perspectives on EPA's draft new SC-GHG methodology and estimates

- Technical perspectives on SC-GHG use/application

Technical perspectives on EPA's draft new SC-GHG methodology and estimates

EPA's draft new SC-GHG methodology and estimates

(publicly released Nov 11, 2022 with proposed oil and gas methane rule)


Docket ID No. EPA-HQ-OAR-2021-0317
September 2022

EPA

Supplementary Material for the Regulatory Impact Analysis for the Supplemental Proposed Rulemaking, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review"

EPA External Review Draft of Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances

Table ES.1: Estimates of the Social Cost of Greenhouse Gases (SC-GHG), 2020-2080 (2020 dollars)

	SC-GHG and Near-term Ramsey Discount Rate								
	$SC\text{-}CO_2$ (*2020 dollars per metric ton of CO_2*)			$SC\text{-}CH_4$ (*2020 dollars per metric ton of CH_4*)			$SC\text{-}N_2O$ (*2020 dollars per metric ton of N_2O*)		
Emission Year	2.5%	2.0%	1.5%	2.5%	2.0%	1.5%	2.5%	2.0%	1.5%
2020	120	190	340	1,300	1,600	2,300	35,000	54,000	87,000
2030	140	230	380	1,900	2,400	3,200	45,000	66,000	100,000
2040	170	270	430	2,700	3,300	4,200	55,000	79,000	120,000
2050	200	310	480	3,500	4,200	5,300	66,000	93,000	140,000
2060	230	350	530	4,300	5,100	6,300	76,000	110,000	150,000
2070	260	380	570	5,000	5,900	7,200	85,000	120,000	170,000
2080	280	410	600	5,800	6,800	8,200	95,000	130,000	180,000

Values of $SC\text{-}CO_2$, $SC\text{-}CH_4$, and $SC\text{-}N_2O$ are rounded to two significant figures. The annual unrounded estimates are available in Appendix A.4 and at: www.epa.gov/environmental-economics/scghg.

- **New methodology:** Module-by-module development (recommended by Rose et al (2014, 2017) and NASEM (2017))
- **Appropriate scientific review?** To be determined
- **EPRI finds technical issues:** see subsequent slides
- **Use of estimates:** Biden Administration already using despite draft status and impending peer review

EPRI

High-level technical observations

- After thorough review, we find that the methodology and estimates are not yet scientifically reliable and robust for policy use
- The methodology contains multiple significant technical issues and does not satisfy the National Academies of Sciences, Engineering, and Medicine's (NASEM) recommendations
  - Both should be addressed before the estimates are deployed to inform policy
- In our public comments, we identified key technical issues that we observed and provided overall and module-specific recommendations

EPRI public comments on EPA's draft new SC-GHG methodology and recent use (2/13/2023, available at www.epri.com/sc-ghg)

February 13, 2023

Subject: Public comments on U.S. EPA proposed oil and gas methane rule and draft new SC-GHG estimation methodology (Docket ID No. EPA–HQ–OAR–2021–0317)

Dear Administrator Regan,

Thank you for the opportunity to comment on the proposed oil and gas methane rule Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review and its use of social cost of greenhouse gas estimates (SC-GHGs) and EPA's draft new SC-GHG estimation methodology that was first released to the public along with this proposed rule on November 11, 2022.

EPRI is a nonprofit, scientific research organization with a public benefit mission. EPRI strives to advance knowledge and facilitate informed public discussion and decision-making. In addition to extensive research and expertise related to the social cost of carbon and other greenhouse gases, EPRI has a long history of research community leadership and participation in the Intergovernmental Panel on Climate Change (IPCC), U.S. National Climate Assessment, EPA's Science Advisory Board, and National Academy of Science, Engineering, and Medicine (NASEM).

As an independent and objective science organization, EPRI appreciates the importance of facilitating the development of grounded SC-GHG estimates and applications and engaging the public through comment opportunities such as this to help do so. Our comments reflect our review of the draft new SC-GHG methodology and documentation and the application of SC-GHG estimates in the proposed rule in light of the NASEM Social Cost of Carbon Committee recommendations (NASEM, 2016, 2017), technical challenges EPRI had previously identified (EPRI, 2021a), and the overall body of scientific knowledge.

EPRI has been engaged in SC-GHG research for almost two decades and has over forty years of related research experience in the core sciences underlying SC-GHG calculations, including integrated assessment modeling, socioeconomic projections and decarbonization transitions, climate modeling and scenarios, impacts and damages modeling, economics, and climate policy. EPRI's SC-GHG research includes analyzing in detail the models and assumptions used for SC-GHG estimation, as well as detailed assessment of applications using SC-GHG estimates. See the appendix for examples of EPRI's SC-GHG related research, including EPRI's 2021 publication discussing key technical challenges that need to be addressed by any new SC-GHG estimation approach (EPRI, 2021a).

EPRI's expertise and research led to Dr. Steven Rose's participation on the NASEM Social Cost of Carbon Committee as a committee member. EPRI's assessment of the IWG SC-GHG estimation framework used by this and previous administrations (Rose et al, 2017, 2014) was a primary input into the NASEM SCC Committee deliberations and the resulting NASEM studies and their recommendations (NASEM, 2016, 2017). These are the same NASEM studies referenced in the President's January 2021 Executive Order 13990 (Executive Order on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis) as important methodological resources the interagency working group (IWG) and individual agencies should consider when developing an updated SC-GHG methodology.

1

Overall recommendations regarding methodology

- **Revise the methodology documentation** to facilitate a comprehensive and thorough assessment
  - Reorientating the documentation to focus on establishing the methodology's scientific reliability and robustness
  - Include significantly more methodological details, intermediate and final results, and assessment, comparison, justification
- **Revise the methodology to ensure scientifically reliable and robust estimates**:
  - Revise to fully satisfy the NASEM recommendations (Rec 2-2 & module recommendations)
  - Address technical challenges identified by EPRI (2021)
  - Develop the methodology needed and not constrain consideration to the peer reviewed literature
  - More fully incorporate current scientific knowledge
  - Revise each module to address observed technical issues (see module-specific recommendations)
- **After revising the methodology and documentation, provide the following:**
  - A separate dedicated public comment opportunity
  - A peer review appropriate for a regulatory methodology with significant implications

NASEM (2017) Recommendation 2-2

NASEM Recommendation 2-2 recommended that future methodologies needed the following:

- **Scientific basis:** Modules, their components, their interactions, and their implementation should be consistent with the state of scientific knowledge as reflected in the body of current, peer-reviewed literature.
- **Uncertainty characterization:** Key uncertainties and sensitivities, including functional form, parameter assumptions, and data inputs, should be adequately identified and represented in each module. Uncertainties that cannot be or have not been quantified should be identified.
- **Transparency:** Documentation and presentation of results should be adequate for the scientific community to understand and assess the modules. Documentation should explain and justify design choices, including such features as model structure, functional form, parameter assumptions, and data inputs, as well as how multiple lines of evidence are combined. The extent to which features are evidence based or judgment-based should be explicit. Model code should be available for review, use, and modification by researchers.

EPA draft new methodology based on very little literature and heavily dependent on Resources for the Future (RFF) approach

EPA computation module	Source information
Socioeconomics & emissions projections	RFF approach (Rennert et al, 2022)
Climate modeling	RFF approach (Rennert et al, 2022)
Climate damages estimation	• DSCIM (Climate Impacts Lab, 2022) • GIVE (Rennert et al, 2022) • Howard and Sterner (2017) meta analysis
Discounting future damages	RFF approach (Rennert et al, 2022)

EPA's draft socioeconomic and emissions projections module

Description

- Population: UN probabilistic 2100 projections extended to 2300
- Income: statistical estimated country income per-capita growth projections, reweighted with expert elicitation input
- Emissions: projections based on expert elicitation of potential future emissions (with climate policy)

EPRI technical observations

- Not fully addressing NASEM recommendations
- Heavy reliance of multiple separate expert elicitations
- Ignoring important socioeconomic and emissions structural details, coherency, and plausibility
- Inter-module relationships unclear
- Additional details and results needed

Figure 2.1.1: Global Population under RFF-SPs and SSPs, 1950-2300

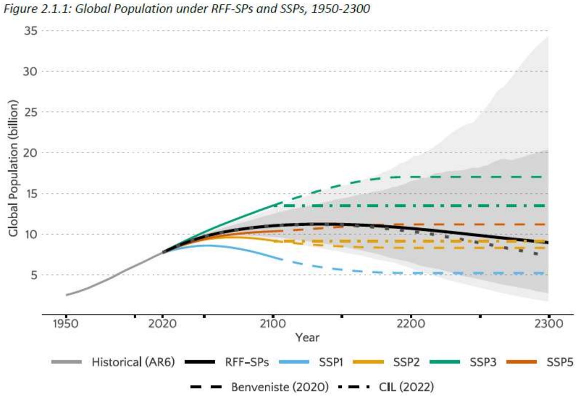


Figure 2.1.2: Long-run Projections of Growth in Global Income per Capita under RFF-SPs and SSPs, 2020-2300

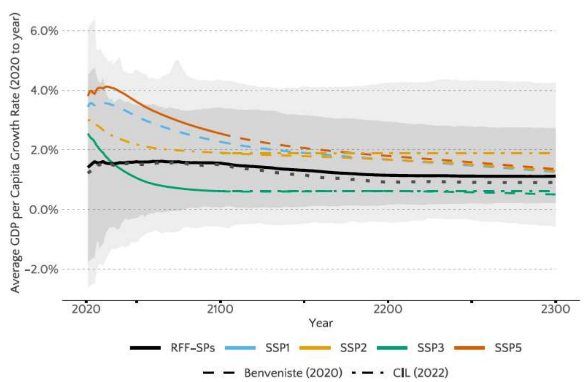
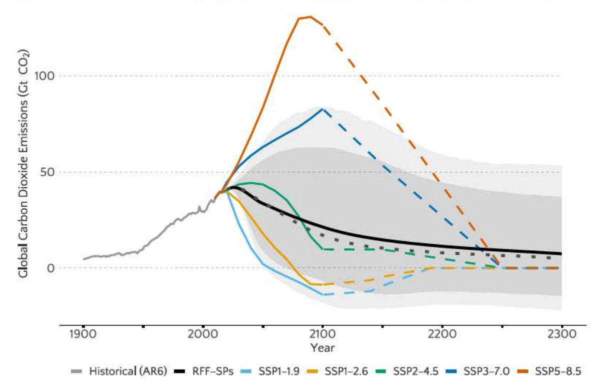


Figure 2.1.3: Net Annual Global Emissions of Carbon Dioxide (CO_2) under RFF-SPs and SSPs, 1900-2300



EPA's draft climate modeling module

Description

- FaIR model used with its parametric uncertainty
  - Output: global average temperature change
- Modeling CO_2, CH_4, and N_2O climate responses with carbon cycle feedbacks
- Other earth system components: sea-level rise (two models – FACTS & BRICK)

EPRI technical observations

- Not fully addressing NASEM recommendations
- One reduced complexity climate model used with limited comparison
- Other non-GHG forcings (e.g., aerosols) fixed and identical across projections
- Global climate only – regional climate response uncertainty not considered
- Additional details and results needed

Figure 2.2.2: Global Mean Surface Temperature Change, 1900-2300

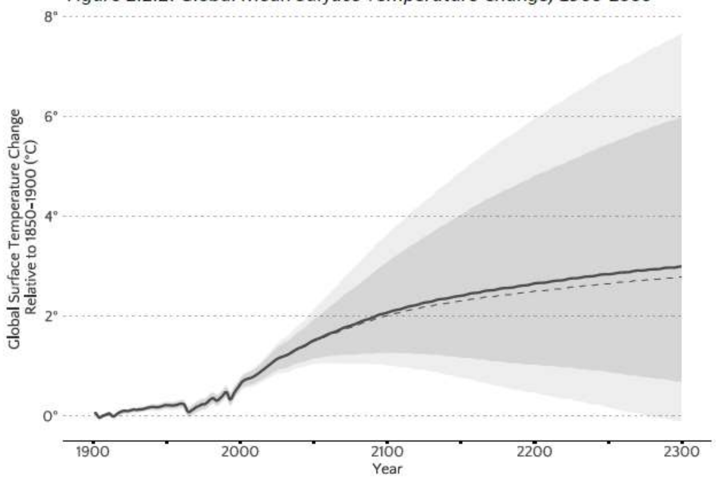
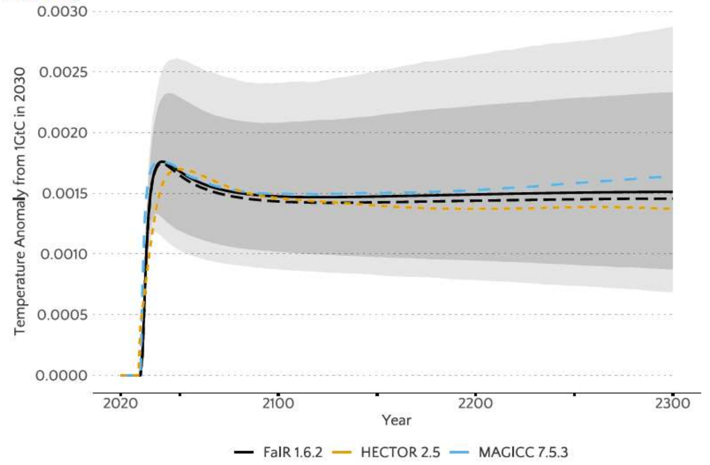


Figure 2.2.3: Global Mean Surface Temperature Anomaly from a Pulse of Carbon Dioxide (1GtC) by Model, 2020-2300



EPA’s draft climate damages approach

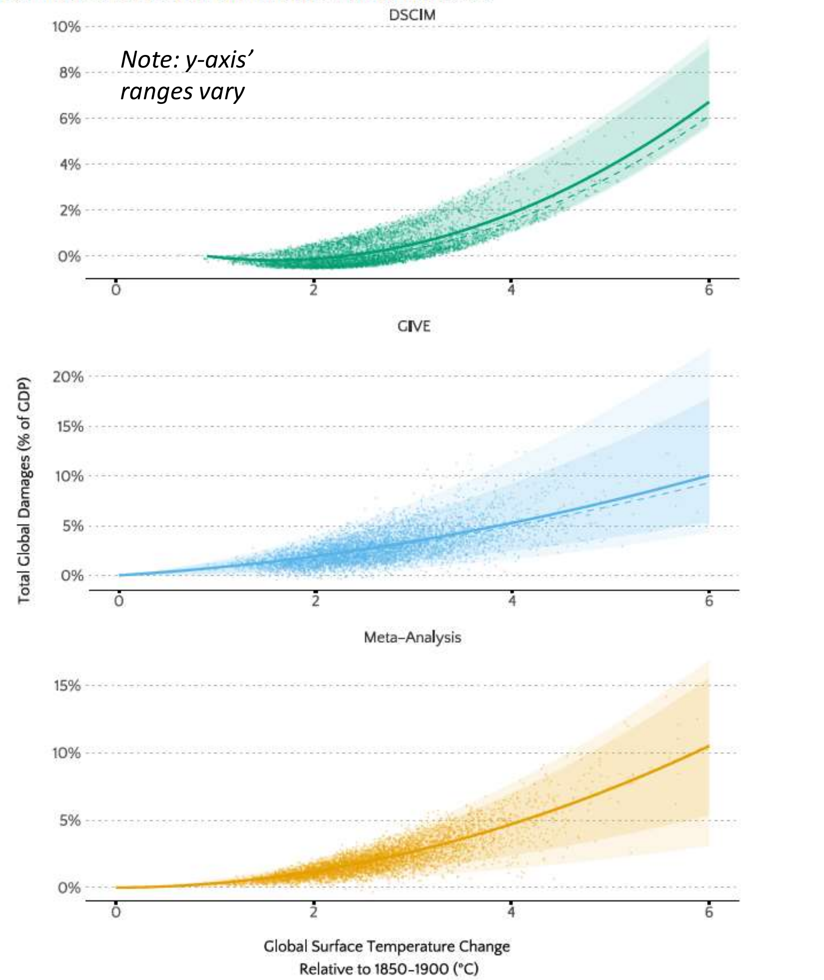
Description

- Three damage estimation approaches (weighted equally)
  - DSCIM (Climate Impacts Lab) – sum of 5 impacts categories, each based on separate statistical modeling
  - GIVE (RFF approach) – sum of 4 impacts categories, each based on separate structural modeling
  - Howard and Sterner (2017) – meta-analysis of global aggregate functions in previous literature

EPRI technical observations

- Not fully addressing NASEM recommendations
- Very narrow representation of the literature
- No assessment or consideration of incomparability issue NASEM and IPCC identified (i.e., differences and methods and biases and uncertainty specifications)
- Uncertainty not well captured
- Adaptation considerations mixed
- No interaction between damage categories
- Additional details and results needed

Figure 2.3.2: Annual Consumption Loss as a Fraction of Global GDP in 2100 Due to an Increase in Annual Global Mean Surface Temperature in the three Damage Modules



EPA's draft discounting approach

Description

- Shifted to dynamic discounting (from constant)
  - The discount rate at each point in time is a function of projected economic growth. Recommended by NASEM.
- Global discounting being done for projections to 2300
- Using three dynamic global discounting parameterizations with near-term target discount rates of 1.5%, 2%, and 2.5%

EPRI technical observations

- The parameterization choices are not consistent with the full set of relevant considerations
- Regarding the near-term target rate, EPA claims a "consumption" rate is appropriate and they appear to see this as an update to OMB's Circular A-4 3% rate. However, …
  - Consumption trade-offs do not appear to be computed in the damage calculations
  - OMB's A-4 "consumption" rate is for shorter-run investments (e.g., 10-year), not very long-run investments (e.g., 100-year)
- Global discount rates are inconsistent with regional economic growth assumptions
- Additional details and results needed

Dynamic discounting Ramsey formula

$$r_\tau = \rho + \eta g_\tau$$

Discount rate in period tau = Pure rate of time preference (PRTP) + Elasticity of the marginal utility of consumption (absolute value) x Growth in per capita consumption in period tau

EPA draft dynamic discounting parameters

Table 2.4.2: Calibrated Ramsey Formula Parameters

Near-Term Target Certainty-Equivalent Rate	ρ	η
1.5%	0.01%	1.02
2.0%	0.20%	1.24
2.5%	0.46%	1.42

Source: Rennert et al. (2022b)

EPRI discounting module recommendations

- Revise to fully address NASEM recommendations (Rec 2-2),
- Revise dynamic discounting approach calibration choices to take into account the full set of relevant considerations, which would include revising the near-term target rates to 3-5%, the growth rate assumption to higher than implied, and discounting regionally,
- Remove the feature netting out damages from economic growth to ensure discounting consistency with projected growth,
- Revisit the fixed savings rate assumption for consistency with economic growth and historical evidence, and
- Provide needed additional methodological details and justification to facilitate a full assessment.

Assumed near-term target rate

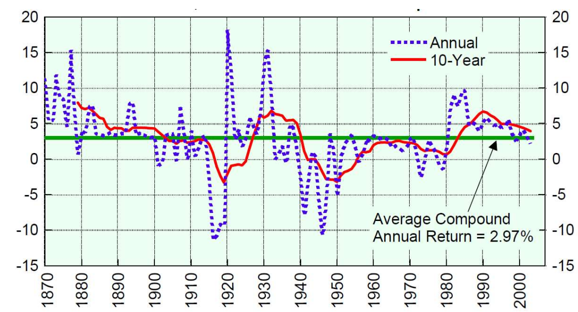
Table 2.4.2: Calibrated Ramsey Formula Parameters

Near-Term Target Certainty-Equivalent Rate	ρ	η	Implied assumed calibration economic growth rate
1.5%	.0001	1.02	1.45%
2.0%	.0020	1.24	1.45%
2.5%	.0046	1.42	1.45%

Source: Rennert et al. (2022b)

- Need to be consistent with duration of investment (100+ yrs), very long-run historical observations (150+ yrs), type of damages trade-off modeled, and viable calibration choices (rho, eta, and assumed growth)
- **Near-term target discount rates of 3% to 5% are consistent – 3% if damages computed are consumption trade-offs, 5% if damages computed are investment trade-offs**
  - 3% consistent with very-long run historical record for social security interest rate
  - 5% consistent with the very-long observations for very-long-run private investment trade-offs (e.g., public dam projects, nuclear waste), and very-long-run economic modeling, including that considering both benefits and costs and market and non-market damages (e.g., Nordhaus, 2010, 2017; Manne and Richels, 1992).

Analysis of government real interest rate for Social security – annual percent, and annualized 10-year compound return (Girola, 2005)



The importance of dynamic discounting calibration choices

Some calibrations invalid (red) or questionable (orange). Source: EPRI

		Calibration 1		Calibration 2		Calibration 3		Calibration 4	
Near-term target discount rate	Assumed per capita consumption growth rate	PRTP (ρ)	Elasticity (η)	PRTP (ρ)	Elasticity (η)	PRTP (ρ)	Elasticity (η)	PRTP (ρ)	Elasticity (η)
1.0%	2.0%	0.1%	0.45	0.5%	0.25	1.0%	0.00	2.0%	-0.50
1.5%	2.0%	0.1%	0.70	0.5%	0.50	1.0%	0.25	2.0%	-0.25
2.0%	2.0%	0.1%	0.95	0.5%	0.75	1.0%	0.50	2.0%	0.00
2.5%	2.0%	0.1%	1.20	0.5%	1.00	1.0%	0.75	2.0%	0.25
3.0%	2.0%	0.1%	1.45	0.5%	1.25	1.0%	1.00	2.0%	0.50
4.0%	2.0%	0.1%	1.95	0.5%	1.75	1.0%	1.50	2.0%	1.00
5.0%	2.0%	0.1%	2.45	0.5%	2.25	1.0%	2.00	2.0%	1.50

Near-term target rates of 3% - 5% have potentially viable calibration candidates

				n 2		Calibration 3		Calibration 4	
N discount rate	rate				asticity (η)	PRTP (ρ)	Elasticity (η)	PRTP (ρ)	Elasticity (η)
1.0%	1.45%	0.1%	0.62	0.5%	0.34	1.0%	0.00	2.0%	-0.69
1.5%	1.45%	0.1%	0.97	0.5%	0.69	1.0%	0.34	2.0%	-0.34
2.0%	1.45%	0.1%	1.31	0.5%	1.03	1.0%	0.69	2.0%	0.00
2.5%	1.45%	0.1%	1.66	0.5%	1.38	1.0%	1.03	2.0%	0.34
3.0%	1.45%	0.1%	2.00	0.5%	1.72	1.0%	1.38	2.0%	0.69
4.0%	1.45%	0.1%	2.69	0.5%	2.41	1.0%	2.07	2.0%	1.38
5.0%	1.45%	0.1%	3.38	0.5%	3.10	1.0%	2.76	2.0%	2.07

Source: EPRI

Technical perspectives on SC-GHG use/application

Improving SC-GHG use – an immediate priority

- How SC-GHG values are used is equally important to how they are estimated
  - EPRI has assessed use and found fundamental technical issues that affect scientific reliability of GHG reduction benefit and net benefit calculations and conclusions – Rose and Bistline (2016), Bistline and Rose (2018), EPRI (2021), EPRI (2023)
- For instance, the recent proposed oil & gas methane rule needs to revise the benefit-cost calculations to address the following (EPRI, 2023):
  - Inconsistencies in benefit and cost calculation assumptions and uncertainty
  - Net benefit calculation discounting inconsistencies
  - Need to expand analysis to account for SC-GHG uncertainty for each discounting structure
  - Accounting for emissions leakage
  - Avoiding pricing CH_4 more than once across policies
- EPRI analyses have found SC-GHG application issues to be common
  - e.g., regulatory analyses, NEPA assessments, procurement, budgeting, wholesale power dispatch CO_2 pricing, social pricing of energy (social price of fuel = market price + GHG externality), global climate goal and legislative proposal analyses
- Need guidance for properly using SC-GHG estimates to ensure scientifically reliable policy insights

EPRI application evaluation checklist

Appropriate use?

Avoiding double pricing GHGs?

Full monetization?

Accounting for leakage?

Cost-benefit calculation consistency (discounting, assumptions, uncertainty, value types)?

Accounting for SC-GHG uncertainty (for a discounting structure)?

Not conflating company risk management?

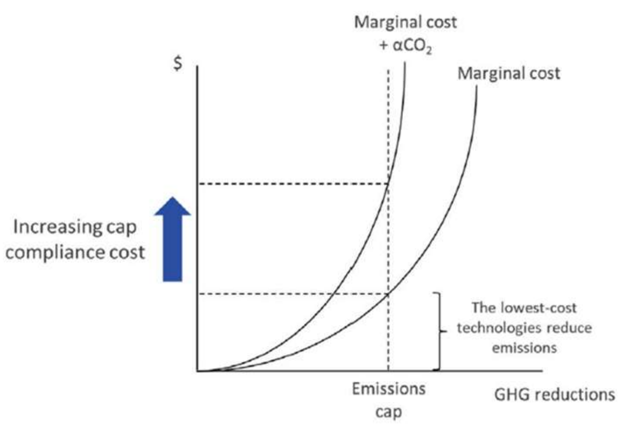
Application-specific issues?

Pricing CO_2 (any GHG) more than once costly for society

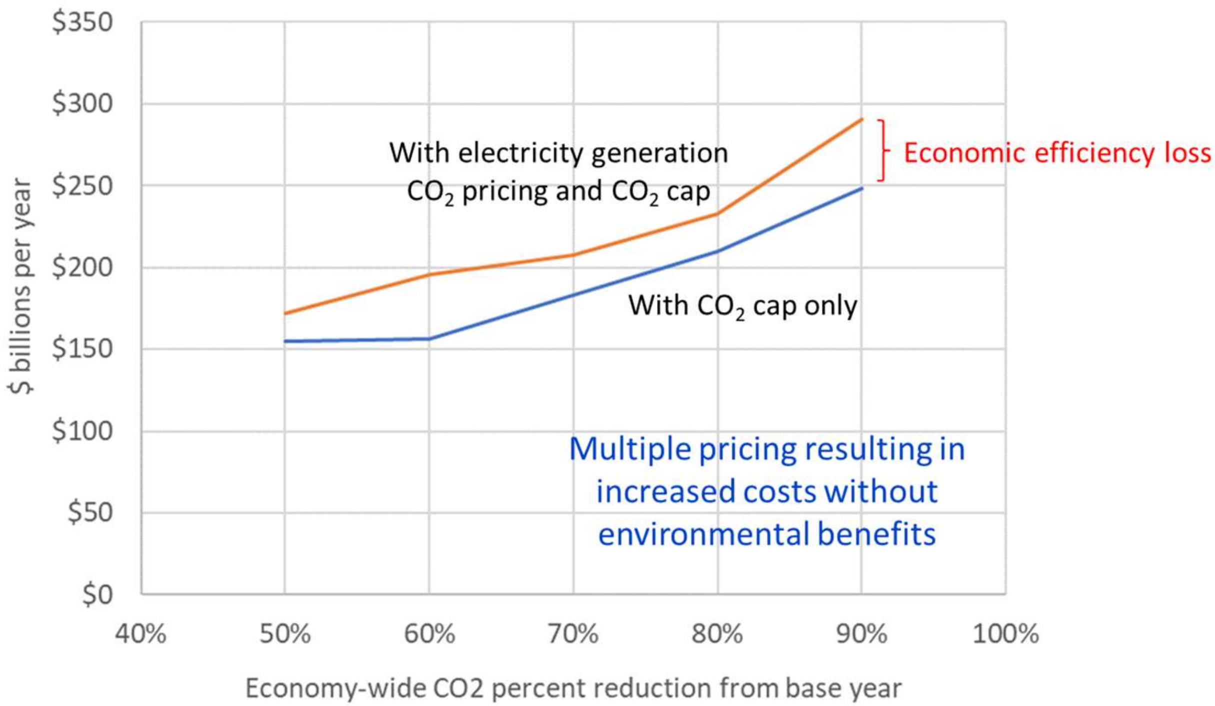
EPRI preliminary modeling analysis exploring economic efficiency implications of pricing CO_2 more than once

Additional combinations being evaluated

Example – CO_2 pricing on top of an emissions cap



Emissions reduction supply in 2050 without and with multiple CO_2 policies



Source: EPRI preliminary

Closing remarks

- This is not an academic exercise
- The draft new SC-GHG estimates are not scientifically reliable and robust
  - Insufficient information for a full and proper assessment
  - Not satisfying NASEM recommendations
  - Specific technical issues in every module
- EPA's planned peer review appears unlikely to address these issues and provide the public with confidence in the outcome
  - Problems: panel expertise, peer review process (charge, review implementation, duration, meetings, public engagement)
- Overall, the administration is not doing what is needed for scientific reliability and robustness – scientific due diligence
- Technical issues associated with applying SC-GHG estimates are a problem now, affecting decisions, not being addressed
- EPRI will continue to help educate and facilitate the development of scientifically reliable estimates and use
  - Technical analyses (e.g., discounting, application), public educational webcast series, SC-GHG website

Putting science first in creating and using the social cost of carbon
S Rose, *The Hill*, Nov. 18, 2022.

Stakeholders need to demand scientific due diligence in order to have scientific reliability and robustness in SC-GHG estimates and applications

Facilitating development of scientifically reliable estimates and use

https://www.epri.com/sc-ghg

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See website for SC-GHG technical insights, public comments, and resources.
Sign-up for our SC-GHG mailing list by emailing eea@epri.com.

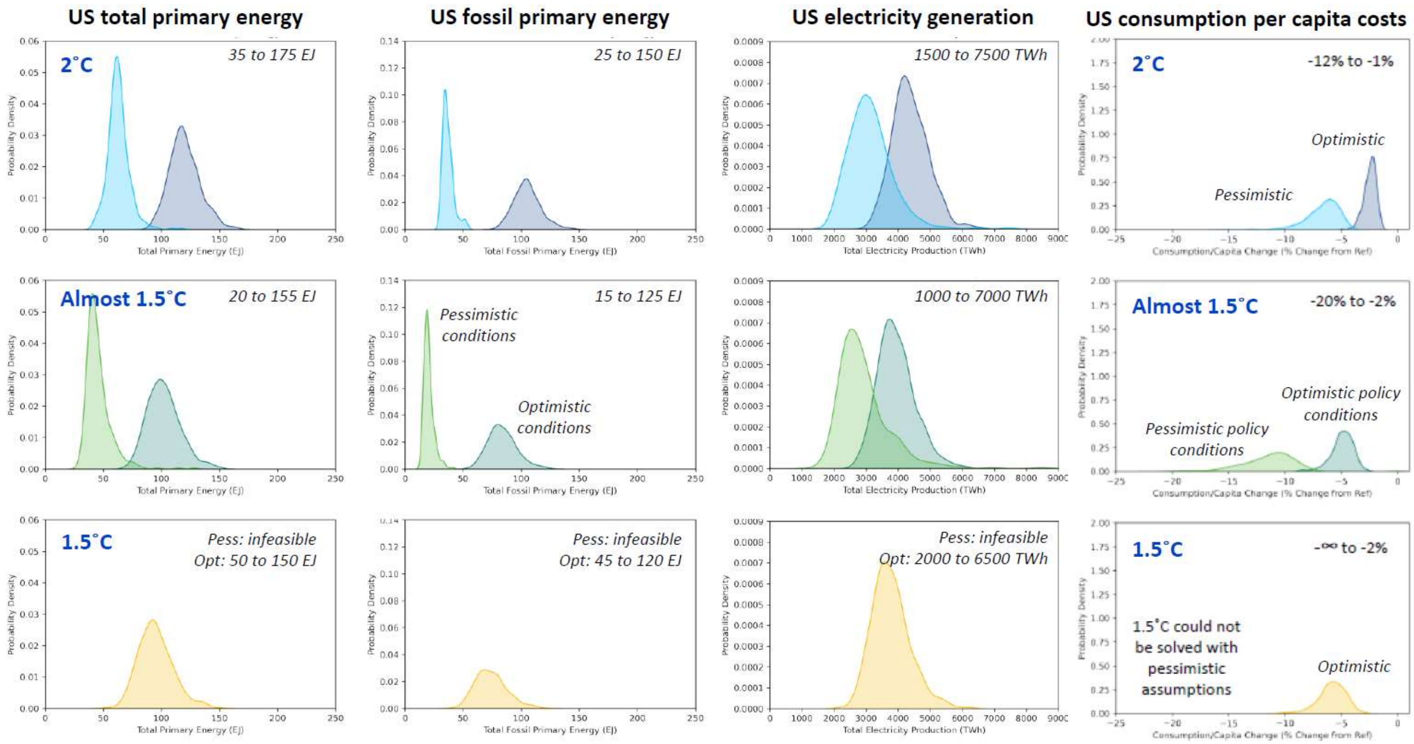
Appendix

EPRI socioeconomic and emissions module recommendations

- Revise to fully address NASEM recommendations (Recs 2-2, 3-1, 3-2),
- Revise the socioeconomic and emissions projections for coherency, consistency, and to account for important structural details,
- Remove implausible socioeconomic and emissions projections,
- Revisit post-2100 projection assumptions for coherency and consistency with historical behavior,
- Provide transparency and justification on linkages to other modules, in particular climate damages and discounting, and
- Provide needed additional methodological details and results to facilitate a full assessment.

Illustration of socioeconomic structure and coherency

- Example of structural coherency and uncertainty
- Example of policy design relevance
- Example of climate policy cost feedbacks on regional consumption and income
- Example of implausibility issue



EPRI-MIT (forthcoming)

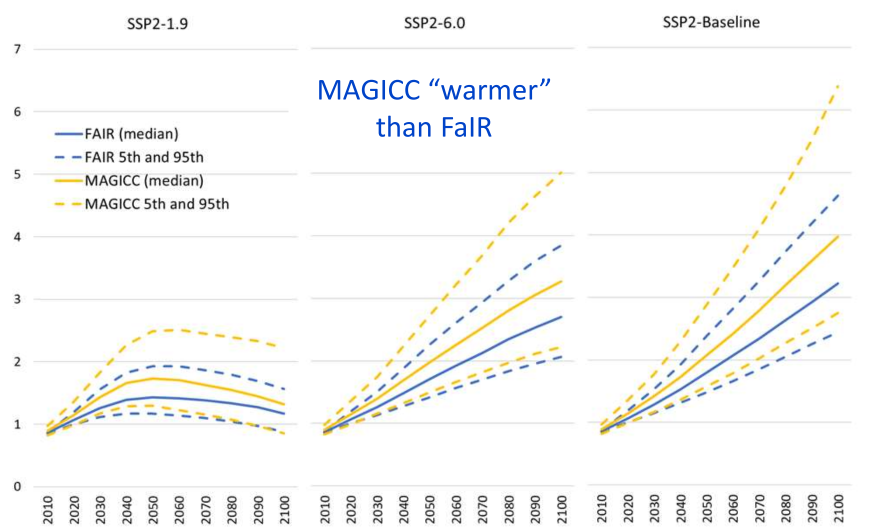
Matters for damages (defines size, composition, net impacts, adaptation) & discounting (economic growth)

EPRI climate modeling module recommendations

- Revise to fully address NASEM recommendations, including undertaking NASEM performance tests (Recs 2-2, 4-1, 4-2, 4-5)
- Expand evaluation and comparison to justify the approach and better account for uncertainty,
- Endogenize non-GHG radiative forcing to address the current fixed forcing assumption's inconsistency with the broad range of projected futures and to capture non-GHG forcing uncertainty in temperature projections, and
- Provide needed additional methodological details and results to facilitate a full assessment.

Alternative climate modeling and regional climate change – examples

FAIR vs. MAGICC global mean temperature change (median, 5th and 95th percentile)



Regional climate change responses (sample ranges shown in table)

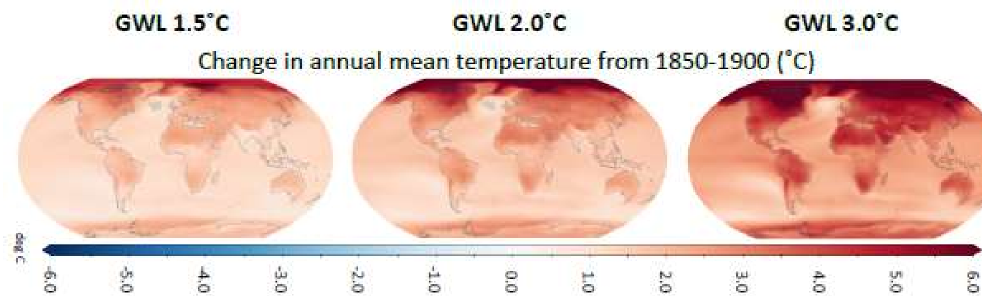


Table 3. Sample of continental temperature and precipitation ranges by GWL. Ranges are 5th and 95th percentiles from climate model inter-comparison results. Constructed from IPCC (2021) Interactive Atlas.

Climate Variable	Region	Global Warming Level			
		1.5ºC	2ºC	3ºC	4ºC
Mean temperature (ºC)	North America	4 to 8	5 to 9	6 to 11	8 to 11
	Africa	24 to 26	24 to 27	25 to 28	26 to 29

EPRI (2021)

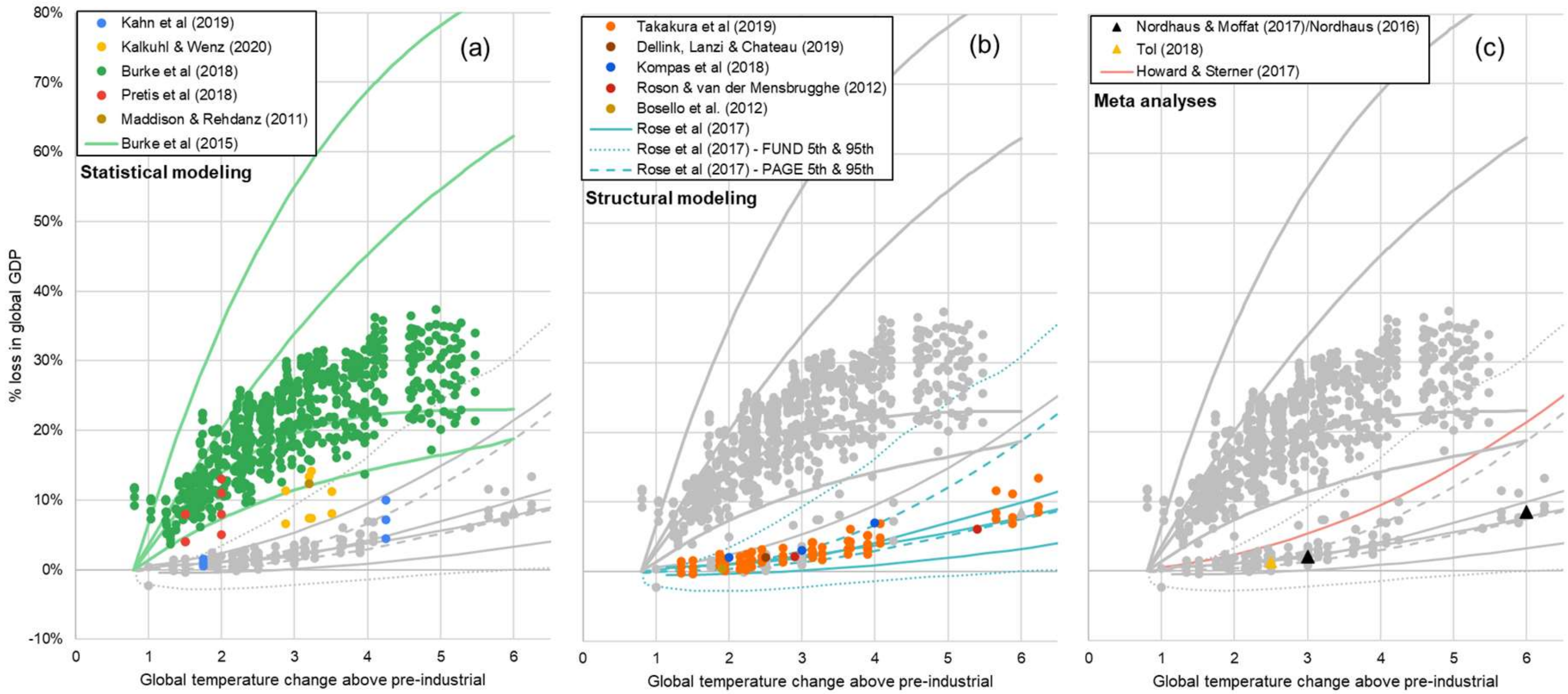
EPRI climate damages module recommendations

- Revise to fully address NASEM recommendations (Recs 2-2, 5-1),
- Assess the literature used and addressing the methodology comparability issue identified by the NASEM and IPCC,
- Consider the fuller literature to more accurately estimate damages and account for uncertainty, and
- Provide needed additional methodological details and results to facilitate a full assessment.

IPCC provided additional estimates to consider and found methodological incomparability to be an issue

- The wide range, and the lack of comparability between methodologies, does not allow for identification of a robust range of estimates with confidence (high confidence)
- Significantly greater spread in estimated values, including for today's level of warming, due primarily to differences in methods
- Evaluating and reconciling differences in methodologies is a research priority for facilitating use of the lines of evidence (high confidence)

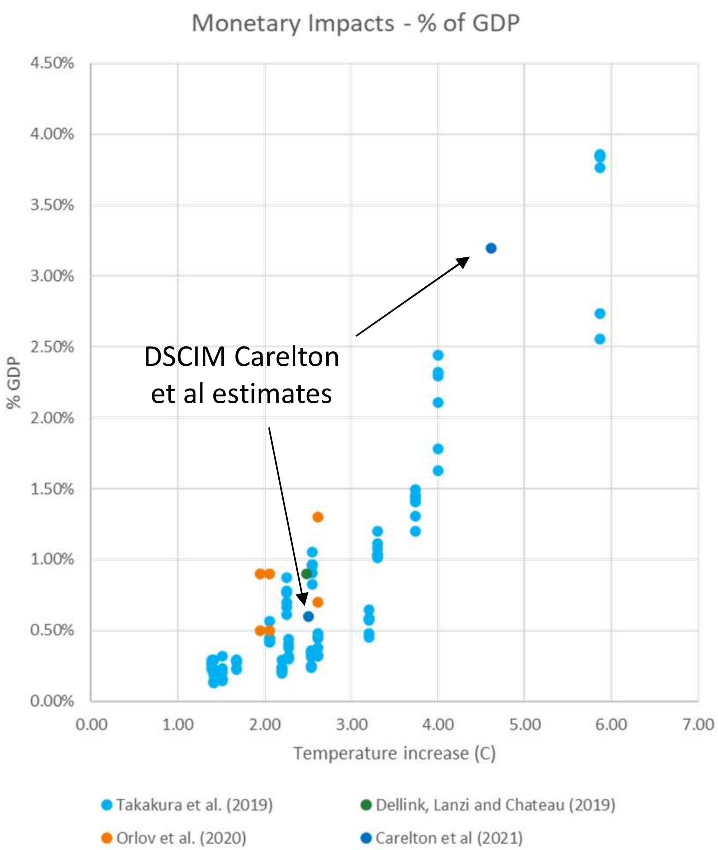
Global aggregate economic impact estimates by global warming level
(% global GDP loss, all estimates from a paper have the same color)



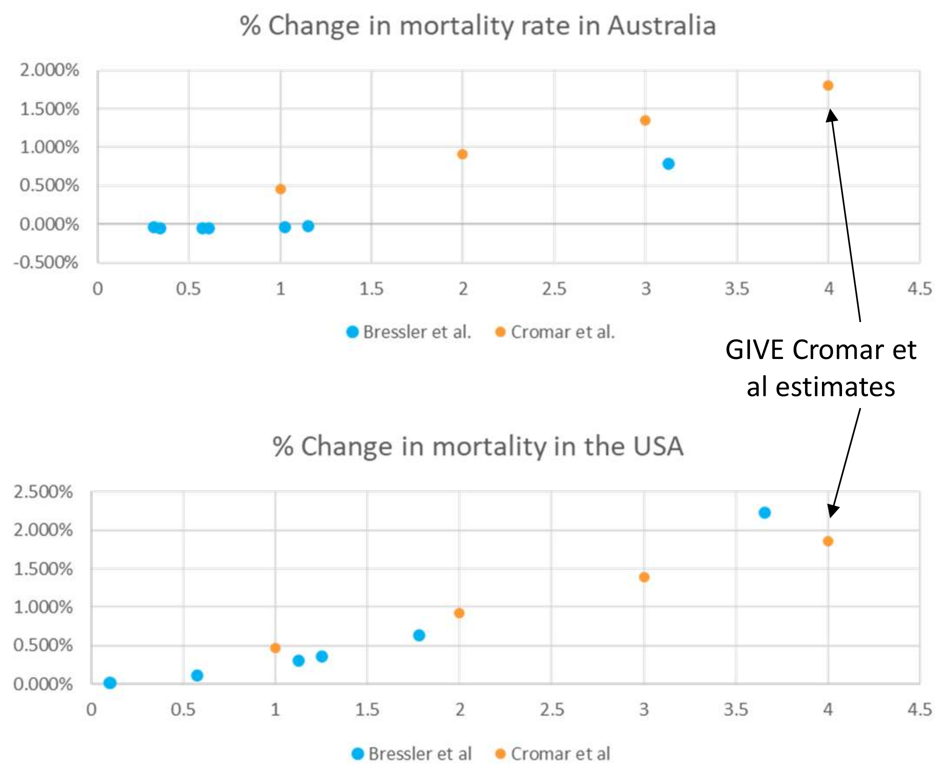
Source: Estimating Global Economic Impacts from Climate Change. In Climate Change 2022: Climate Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the IPCC, Chapter 16 Cross-Working Group Box.

Other climate damages literature – human health

Examples of global monetary damage estimates



Examples of regional physical mortality estimates



What matters? How captured? Needs assessment!

1. Modeling local climate
2. Modeling net physical response
3. Valuing net changes
4. Deriving aggregate metric (e.g., % GDP)

Source: EPRI

EPRI

Other EPRI methodology recommendations

- For the SC-GHG estimates results in the documentation, we recommend providing more detailed SC-GHG results, discussion, assessment, and justification to allow for full assessment.
- For cross-module linkages, we recommend providing transparency, including equations, parameters, and examples regarding module linkages and integration, and including discussion of consistency and uncertainty.
- For the GHG emissions pulses, we recommend revisiting the large GHG emissions pulse size used (1 GtC for SC-CO_2 calculations) and discussing and assessing non-linearity and justifying choices.

Figure 3.1.1: Distribution of Social Cost of Carbon Dioxide (SC-CO2) Estimates for 2030, by and Damage Module, for Near-term Ramsey Discount Rate of 2%

EPA (2022)

Table 3.1.4: Sectoral Disaggregation of Social Cost of Carbon (SC-CO_2) for 2030 under a 2.0% Near-Term Ramsey Discount Rate (in 2020 dollars per metric ton of CO_2)

	Damage Module		
Damage sector or category	DSCIM	GIVE	Meta-Analysis
Health	$179	$104	-
Energy	-$4	$10	-
Labor productivity	$47	-	-
Agriculture	$4	$103	-
Coastal	$3	$2	-
Total	$233	$219	$238

EPA (2022)

EPRI comments on the peer review (EPRI, 2023, 2022)

A peer review appropriate for a regulatory methodology with significant implications is needed

- As discussed in our previous public comments (EPRI, 2022), the planned peer review should be enhanced to provide the public with confidence in the outcome. As a result, **EPRI recommends that EPA develop a scientific review process appropriate for a regulatory methodology**. See EPRI (2022) for details. Briefly this entails:

- Explicitly requesting peer review of the scientific reliability and robustness of the methodology and estimates,
- Reviewing every detail, choice, and justification, as well as intermediate internal calculations and final estimates,
- Selecting an appropriate peer review panel to carry out the peer review,
- Requiring consensus recommendations from the review panel, including a consensus decision on whether the methodology and estimates are robust and reliable,
- Avoiding use of the new estimates until the peer review panel has established the methodology's scientific reliability, which may require methodology revisions and re-review iterations, and
- A review that follows EPA's peer review guidance (USEPA, 2015).

An appropriate peer review panel is needed

- Selecting an appropriate peer review panel is essential. EPRI (2022) **recommends revising the peer review candidate selection process and list to ensure full and objective coverage of the core scientific disciplines underpinning the SC-GHG.** See EPRI (2022) in Appendix B for details. Revising the peer review candidates includes:

- Revising the panel selection criteria for the needed core science expertise and avoiding conflicts of interest and scientific biases,
- Assembling the panel needed in terms of expertise and size, with at least 14 panelists required—two experts for each of the relevant core scientific disciplines (and sub-disciplines related to unique methodologies and areas of science), and
- Providing a transparent process with public input regarding the panel criteria and selection.

EPRI's public comments on EPA's planned draft methodology peer review (EPRI, 2022)

- EPRI observes that EPA's proposed peer review and overall scientific process are insufficient to develop scientifically robust and reliable estimates and insufficient for the public to have confidence in the outcome.

- Based on EPRI's research and experience in this area, the process needs to:
  1. Revise the peer review candidate selection process and list to ensure full and unbiased coverage of the core scientific disciplines underpinning the SC-GHG,
  2. Expand the peer review process to a scientific review process appropriate for a regulatory methodology with significant implications,
  3. Substantially increase opportunities for public engagement and input, and
  4. Improve the overall scientific process for developing and using updated SC-GHG estimates.

EPRI

December 1, 2022

Subject: SC-GHG Peer Review

Dear Versar (U.S. EPA contractor for SC-GHG Peer Review Panel),

Thank you for the opportunity to comment on the peer review for the draft social cost of greenhouse gases (SC-GHG) estimation methodology released by U.S. EPA on November 11, 2022 (USEPA, 2022). As a science organization, EPRI appreciates that the President's administration is taking steps to facilitate the development of science-based SC-GHG estimates and applications such as reconstituting the SC-GHG Interagency Working Group (IWG) and engaging the public through comment opportunities such as this. EPRI has been studying SC-GHG methodologies specifically for almost two decades and has over forty years of research experience in the core science underlying SC-GHG calculations. EPRI's SC-GHG research includes analyzing in detail the models and assumptions used for SC-GHG estimation, as well as detailed assessment of applications using SC-GHG estimates. EPRI's expertise and research led to participation on the National Academy of Science, Engineering, and Medicine (NASEM) Social Cost of Carbon Committee as a committee member. EPRI's assessment of the IWG SC-GHG estimation framework used by this and previous administrations (Rose et al, 2017, 2014) was a primary input into the NASEM SCC Committee deliberations and the resulting NASEM studies (NASEM, 2016, 2017). These are the same NASEM studies referenced in the President's January 2021 Executive Order 13990 (Executive Order on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis) as important methodological resources the IWG should consider when developing an updated SC-GHG methodology.

EPRI is a nonprofit, scientific research organization with a public benefit mission. EPRI strives to advance knowledge and facilitate informed public discussion and decision-making. EPRI has recognized scientific expertise in the social costs of carbon and other greenhouse gases, climate scenarios, integrated assessment modeling, socioeconomic and energy system transformation, and climate policy evaluation, as well as a long history of research community leadership and participation in the Intergovernmental Panel on Climate Change (IPCC), National Climate Assessment, and NASEM. See the appendix for examples of EPRI's SC-GHG related research, including EPRI's 2021 publication identifying needed repairs to the "interim" SC-GHG estimation methodology and current applications to ensure scientific reliability, as well as discussion of key technical challenges that need to be addressed by any new SC-GHG estimation approach (EPRI, 2021b).

EPRI has previously provided public comments to the administration discussing the importance of prioritizing science and developing scientifically reliable estimates before use, as well as identifying key challenges to address in developing a new methodology and estimates (EPRI, 2021a, 2021b). EPRI also recently published an article discussing the importance of a sound scientific process to producing scientifically reliable SC-GHG estimates and what that would entail, including successfully completing an appropriate peer review (Rose, 2022).

EPRI observes that EPA's proposed peer review and overall scientific process is insufficient to develop scientifically robust and reliable estimates and insufficient for the public to have confidence in the outcome. Based on EPRI's research and experience in this area, the process needs to:

EPRI's public comments:
https://www.epri.com/sc-ghg

EPRI's public comments – some details

- **Revise the peer review candidate selection process and list to ensure full and unbiased coverage of the core scientific disciplines underpinning the SC-GHG**
  - Revise panel selection criteria – for core expertise needed, conflicts, and biases
  - Select the panel needed – at least 14 panelists (2 for each core disciplinary expertise)
  - Provide a transparent process with public input
- **Expand the peer review process to a scientific review process appropriate for a regulatory methodology with significant implications**
  - Emphasize scientific integrity and robustness to achieve public credibility for guiding decisions with significant social and financial implications
    - Should be significantly more rigorous and critical than a journal article review
  - Require consensus recommendations, including consensus decision on whether the methodology and estimates are robust and reliable
  - Prohibit use of the new estimates until the panel has established the methodology's scientific reliability
  - Follow EPA peer review guidance
- **Substantially increase opportunities for public engagement and input**
  - Provide opportunity for dedicated public input on the draft new methodology
  - Provide opportunity for public input into the peer review process
  - Public input ideally before peer review, not concurrent with it, not after
- **Improve the overall scientific process for developing and using updated SC-GHG estimates**
  - Scientific due diligence required = good scientific process to ensure scientifically robust, reliable, and stable methodology, estimates, and use
    - See comments and the article in *The Hill* for what specifically is required for scientific due diligence
  - Not doing so, leaves the estimates vulnerable to scientific, political and public criticism, even manipulation

SC-GHG application issues found to be common

- EPRI analyses have found SC-GHG application issues to be common, e.g.,
  - **Regulatory analyses** – leakage risk, benefit-cost inconsistencies, ignoring SC-GHG uncertainty, inconsistent use, multiple pricing risk
  - **NEPA assessments** – partial valuation, multiple pricing
  - **Procurement** – multiple pricing risk, inefficient policy instrument, GHG accounting issues, how criteria combined unclear
  - **Budgeting** – multiple pricing risk, partial valuation, how SC-GHG based information used unclear (e.g., balancing considerations), GHG accounting issues, conflating policy and company climate risk management
  - **Wholesale power dispatch CO_2 pricing** – multiple pricing risk, leakage, less efficient policy instrument
  - **Social pricing of energy** (social price of fuel = market price + GHG externality) – multiple pricing risk, potentially inefficient policy instrument
  - **Global climate goal and legislative proposal analyses** – inappropriate applications

- Need detailed guidance for using SC-GHG estimates to ensure scientifically reliable policy insights

EPRI application evaluation checklist

Appropriate use?
Avoiding double pricing GHGs?
Full monetization?
Accounting for leakage?
Cost-benefit calculation consistency (discounting, assumptions, uncertainty, value types)?
Accounting for SC-GHG uncertainty (for a discounting structure)?
Not conflating company risk management?
Application-specific issues?

The Biden Administration's "interim" social costs of GHGs

- "Interim" estimates for CO_2, CH_4, and N_2O
  - Estimates are Obama's values adjusted to $2020
  - Same modeling framework used by Obama, Trump, & Biden
  - SC-GHGs the result of significant aggregation
    - Over models, time, world regions, impact categories, scenarios (e.g., $51 2020 3% SCC derived from 150,000 estimates)
- **Making sense of, and assessing, requires delving into the details**
- **Appropriate scientific review: No**
- **Fundamental technical issues found: See next slide**
- **Uses: dozens of rules, informing Canada and state applications**

Feature	Detail
Multiple SCC models	Three models — DICE, FUND, PAGE
Standardized uncertainties	• Five reference socioeconomic and emissions scenarios (each extended from 2100 to 2300) • One distribution for the climate sensitivity parameter
Model specific parametric uncertainties	In FUND and PAGE climate and damage components
Standardized discounting	three constant discount rates — 2.5%, 3%, and 5%
Thousands of SCC results	150,000 SCC estimates for a given discount rate and year (3 models × 5 socioeconomic scenarios × 10,000 runs each)
Aggregation of results	• Average of 150,000 results for each discount rate and year • "3% (95th percentile)" value is 95th percentile from distribution of 150,000 results with 3% discounting

Source: Rose et al (2017)

Biden Interim SCC, SCM, and SCN Estimates

Table ES-1: Social Cost of CO_2, 2020 – 2050 (in 2020 dollars per metric ton of CO_2)[3]

Emissions Year	5% Average	3% Average	2.5% Average	3% 95th Percentile
	Discount Rate and Statistic			
2020	14	51	76	152
2025	17	56	83	169
2030	19	62	89	187
2035	22	67	96	206
2040	25	73	103	225
2045	28	79	110	242
2050	32	85	116	260

Table ES-2: Social Cost of CH_4, 2020 – 2050 (in 2020 dollars per metric ton of CH_4)

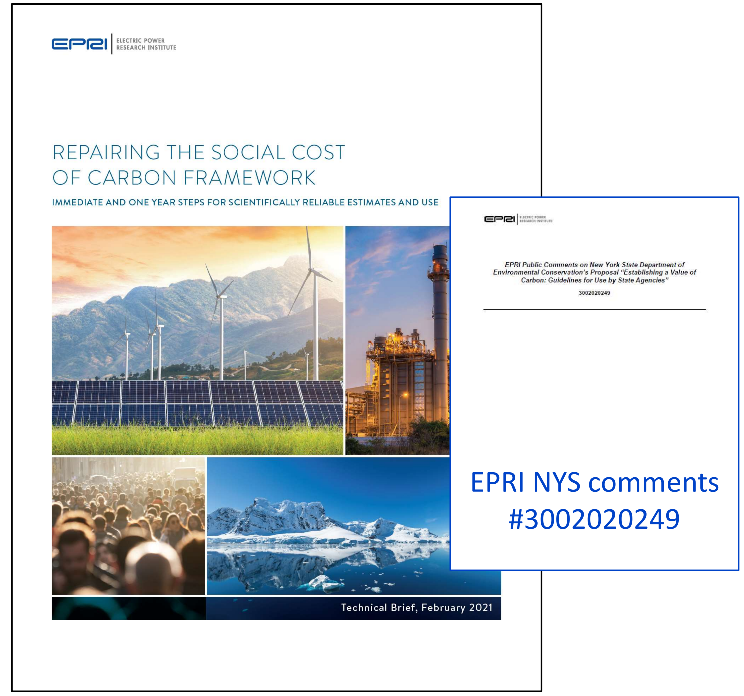
Emissions Year	5% Average	3% Average	2.5% Average	3% 95th Percentile
	Discount Rate and Statistic			
2020	670	1500	2000	3900
2025	800	1700	2200	4500
2030	940	2000	2500	5200
2035	1100	2200	2800	6000
2040	1300	2500	3100	6700
2045	1500	2800	3500	7500
2050	1700	3100	3800	8200

Table ES-3: Social Cost of N_2O, 2020 – 2050 (in 2020 dollars per metric ton of N_2O)

Emissions Year	5% Average	3% Average	2.5% Average	3% 95th Percentile
	Discount Rate and Statistic			
2020	5800	18000	27000	48000
2025	6800	21000	30000	54000
2030	7800	23000	33000	60000
2035	9000	25000	36000	67000
2040	10000	28000	39000	74000
2045	12000	30000	42000	81000
2050	13000	33000	45000	88000

Critical technical issues to address for reliable, robust, and stable estimates and use (EPRI, 2021)

- **Concerns about the "interim" SC-GHG estimation framework**
  - Estimates are not scientifically reliable – remove indefensible elements
- **Immediate concerns about policy application of SC-GHGs**
- **Significant SC-GHG updating technical challenges to overcome**
  - Scientific – overarching methodological and component challenges (e.g., uncertainty, damage estimation, discounting, equity)
  - Alternatives to SC-GHGs if robustness cannot be established
- **Proper scientific and public review for regulatory methodologies is essential before use**

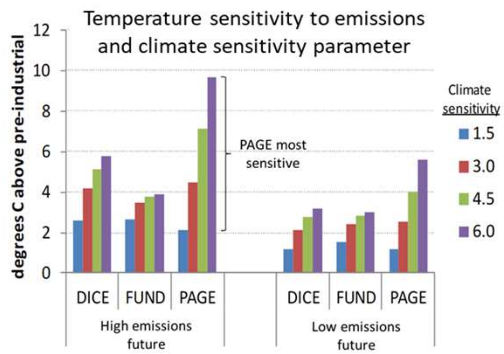


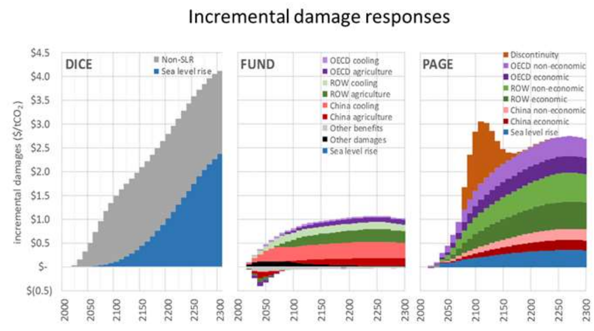
EPRI's unique expertise and analyses – EPRI's SC-GHG research (key input to NAS studies) has found fundamental technical estimation and use issues

Published Feb. 2021: *Repairing the Social Cost of Carbon Framework: Immediate and One Year Steps for Scientifically Reliable Estimates and Use* (#3002020523)

Results from the "interim" IWG Framework are not scientifically reliable (i.e., grounded or robust)

- Detailed component-level assessment (Rose et al, 2014, 2017) found fundamental scientific issues with the individual models, and framework, that undermine confidence in estimates
  - e.g., PAGE (climate sensitivity implementation, undefined damages, regional damage scaling), input scenario plausibility, uncertainty consideration, scientific justification
- Opportunity to improve the interim framework by removing PAGE and indefensible inputs (EPRI, 2021)
- **This research also highlights the importance of elucidating, assessing, and defending the details**





Rose et al (2017)

EPRI assessed SC-GHG modeling and science component-by-component & overall (key input to NASEM studies)

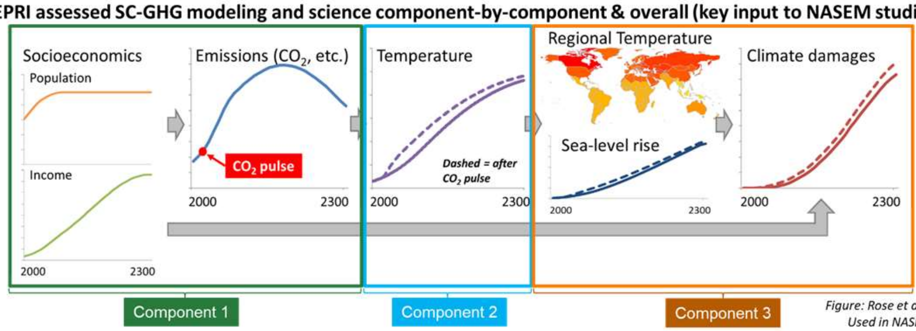


Figure: Rose et al (2017, 2014). Used in NASEM (2017).

***Table 1.** Model evaluation according to the minimum scientific standard*

Scientific Criteria	DICE	FUND	PAGE
Transparency	e.g., damages calibration	Most things described	e.g., unspecified discontinuity damages
Minimum scientific justification	e.g., quadratic damages	e.g., probabilistic parameters	e.g., unsubstantiated discontinuity damage, regional damages scaling, & probabilistic parameters
Minimum scientific functionality	e.g., no climate feedback	e.g., partial radiative forcing	e.g., climate modeling missing structural element
Plausibility	Adequate	e.g., some probabilistic outcomes	e.g., some probabilistic outcomes

Green evaluation indicator = adequate; Yellow = meets minimum but could be improved; Red = inadequate.
Text entries are examples of model specific issues listed in the previous section that support the evaluation color.

EPRI (2021). Derived from Rose et al (2014, 2017)