February 13, 2023

Docket No. EPA–HQ–OAR–2021–0317-1460

Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review Supplemental Notice of Proposed Rulemaking, 87 FR 74702, December 6, 2022

Comments Submitted by Marlo Lewis, Competitive Enterprise Institute (CEI), and Kevin D. Dayaratna, Heritage Foundation[1]

Thank you for the opportunity to comment on the Environmental Protection Agency's proposed rule to "update, strengthen, and expand" methane emission performance standards for new and existing sources in the natural gas sector.[2] If implemented, the proposed standards will impose real and significant compliance costs in the pursuit of illusory climate benefits. The EPA's reliance on the Interagency Working Group's (IWG) deeply flawed social cost of greenhouse gases (SC-GHG) methodology to estimate the proposal's net benefits renders the entire exercise vulnerable to challenge as arbitrary and capricious. The proposal should be withdrawn.[3]

Summary of Key Points

1. The proposed rule would dramatically expand monitoring, performance testing, reporting, enforcement, and compliance expenditures across the sector-wide "supply chain" comprising natural gas exploration, production, storage, processing and transmission. More than 900,000 links in this critical supply chain would be subject to new or more stringent regulatory requirements.

2. The EPA estimates the rule will generate \$55 billion in climate benefits, \$13 billion in compliance costs, \$7.2 billion in net compliance costs (i.e. \$13 billion minus \$5.5 billion in recovered product sales), and net benefits of \$48 billion—a fabulous benefit-cost ratio of 7.6 to 1. That is not credible.

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[1] Dr. Dayaratna is commenting is an independent scholar and this comment should not be construed as reflecting the views of the Heritage Foundation.

[2] EPA, Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing sources: Oil and Gas Sector Climate Review; Supplemental Notice of Proposed Rulemaking, 87 FR 74702, December 6, 2022, https://www.govinfo.gov/content/pkg/FR-2022-12-06/pdf/2022-24675.pdf.

[3] Some of the comments here repeat or adapt points made previously in comments submitted to the EPA and other agencies. See, for example, Comments Submitted by Patrick J. Michaels, Kevin Dayaratna, and Marlo Lewis on the EPA's Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions Standards, Proposed Rule, 83 FR 43726 (August 10, 2021), https://cei.org/wp-content/uploads/2021/09/CEI-Comments-Docket-EPAHQOAR20210208-9-27-2021.pdf.

3. All the proposal's monetized benefits are attributed to an estimated 920 million metric ton (MMT) reduction in carbon dioxide-equivalent (CO_2e) methane (CH_4) emissions during 2025-2023. Plugging that reduction into the EPA's climate policy calculator (MAGICC), the proposal would avert 0.004°C of warming by 2050 and 0.011°C by 2100, assuming 3°C climate sensitivity. Such effects are too small to be detected by scientists or experienced by people and other living things.

4. Undetectable, non-experiential effects are "benefits" in name only. Illusory benefits should not be weighed in the same scales with multi-billion-dollar compliance costs that verifiably impose measurable burdens on identifiable people and businesses.

5. The EPA claims its monetized benefits analysis is solely for the purpose of complying with E.O. 12866 regulatory accounting requirements and did not influence the agency's determination of emission standards. That disclaimer does not shield the rulemaking from legal challenge. If the proposal's putative climate benefits are illusory, costs swamp benefits. Imposing billions of dollars in compliance costs for trivial health or environmental benefits is not rational (*Michigan v. EPA*, 2015).

6. The EPA's climate-benefits calculation is based on the Interagency Working Group's (IWG's) estimates of the social cost of methane (SC-CH_4), a subset of the social cost of greenhouse gases (SC-GHG). As a general observation, SC-GHG estimates are too speculative, and too easily manipulated for political purposes, to inform regulatory decisions. The IWG exercise is a prime example, as all its core methodological choices work to inflate SC-GHG values.

7. Such choices include: Run the climate damage calculators (called "integrated assessment models" or IAMs) with below-market discount rates; use climate sensitivity estimates derived from models that persistently overshoot observed warming; project cumulative damages over a 300-year period—well beyond the limits of informed speculation; minimize the agricultural benefits of atmospheric CO_2 fertilization by averaging the results of three IAMs, two of which do not estimate such effects; low-ball human adaptive capabilities by ignoring the 96% decrease in climate-related deaths since the 1920s and the five-fold decrease in climate damages per exposed GDP since the 1980s; run the IAMs with implausible baselines that assume the world repeatedly burns through all fossil fuel reserves; and, confuse the public by comparing domestic costs (apples) to global benefits (oranges) in regulatory net-benefit calculations.

8. The IWG's mean CO_2 emission baseline for 2000-2300 is more than three times larger than Resources for the Future's (RFF's) new CO_2 baseline projection, which the EPA considers the most realistic available. The IWG's implausibly-high CO_2 emissions baseline inflates SC-CH_4 values and the proposal's associated climate benefits. That is because all GHG emissions contribute to the warming projections used to calculate the incremental damage of an additional ton of any radiatively-active gas.

9. A comparison of the IWG's non-CO_2 GHG emission baselines with the RFF's new baseline projections for methane and nitrous oxide suggests that the IWG's methane baseline projection is itself unrealistically high, further inflating the proposal's climate benefits.

10. The EPA has not discussed or even noted the paradox that, although the new RFF 300-year CO_2 emissions projection is less than one-third the size of the 2021 TSD projection, the SC-CO_2 values calculated with the RFF baseline in the EPA's September 2022 SC-GHG report are 3 to 4 times larger than those in the 2021 TSD. How do dramatic reductions in emission projections yield much larger climate damage estimates?

I. Massive Regulatory Expansion

The EPA's proposal contemplates a monumental expansion of monitoring, performance testing, reporting, enforcement, and compliance expenditures across the sector-wide "supply chain" comprising natural gas exploration, production, storage, processing and transmission. The number of potential links in this supply chain where methane (CH_4) releases may occur is huge. The proposal aims to plug, prevent, or limit CH_4 releases from a wide variety of structures, equipment, and processes:

> As natural gas moves through the necessarily interconnected system of exploration, production, storage, processing, and transmission that brings it from wellhead to commerce, emissions primarily result from intentional venting, unintentional gas carry-through (e.g., vortexing from separator drain, improper liquid level settings, liquid level control valve on an upstream separator or scrubber does not seat properly at the end of an automated liquid dumping event, inefficient separation of gas and liquid phases occurs upstream of tanks allowing some gas carry-through), routine maintenance, unintentional fugitive emissions, flaring, malfunctions, abnormal process conditions, and system upsets. These emissions are associated with a range of specific equipment and practices, including leaking valves, connectors, and other components at well sites and compressor stations; leaks and vented emissions from storage vessels; releases from natural gas-driven pneumatic pumps and controllers; liquids unloading at well sites; and venting or under-performing flaring of associated gas from oil wells.[4]

In all, the EPA itself expects regulatory authorities to manage nearly 1 million supply-chain links. Specifically, the proposed new source standards (NSPS) apply to an estimated 36,150 entities, components, or operations in 2023. When existing source guidelines (EG) take effect in 2026, a staggering 968,320 entities will be subject to new, stricter, or expanded CH_4 regulation, according to the Regulatory Impact Analysis (RIA).[5]

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[4] 87 FR 74705.

[5] EPA, Regulatory Impact Analysis for the Proposed Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review (hereafter RIA), October 2021, Table 2-5, p. 2-25, https://www.epa.gov/system/files/documents/2021-11/proposal-ria-oil-and-gas-nsps-eg-climate-review_0.pdf.

Table 2-5 Projection of Incrementally Impacted Affected Facilities under the Primary Proposed NSPS OOOOb and EG OOOOc Option, 2023 to 2035

Year	Well Sites	Gathering and Boosting Stations	Transmission and Storage Compressor Stations	Natural Gas Processing Plants	Pneumatic Pumps	Pneumatic Controllers	Reciprocating Compressors	Centrifugal Compressors	Liquids Unloading	Storage Vessels
2023	13,000	0	0	130	910	14,000	3,800	30	4,000	280
2024	19,000	0	0	190	1,300	21,000	5,600	44	5,800	410
2025	24,000	0	0	250	1,700	27,000	7,300	57	7,700	560
2026	280,000	3,700	1,900	1,700	33,000	420,000	36,000	1,100	190,000	920
2027	270,000	3,500	1,800	1,800	32,000	410,000	37,000	1,100	180,000	1,000
2028	260,000	3,400	1,800	1,800	31,000	400,000	38,000	1,100	180,000	1,200
2029	260,000	3,200	1,800	1,900	30,000	390,000	38,000	1,100	170,000	1,300
2030	250,000	3,100	1,800	1,900	29,000	370,000	39,000	1,100	160,000	1,400
2031	240,000	3,000	1,800	2,000	28,000	360,000	40,000	1,000	160,000	1,500
2032	240,000	2,900	1,800	2,000	27,000	350,000	41,000	1,000	150,000	1,600
2033	230,000	2,700	1,700	2,100	27,000	340,000	42,000	1,000	150,000	1,700
2034	230,000	2,600	1,700	2,100	26,000	340,000	42,000	1,000	140,000	1,700
2035	230,000	2,500	1,700	2,100	25,000	330,000	43,000	1,000	140,000	1,800

Since methane is the main component of natural gas and a saleable product, oil and gas producers, processers, and transmitters already have strong financial incentives to plug leaks and capture fugitive emissions. What benefit-cost calculation makes the proposed regulatory surge a smart investment of public and private resources?

The EPA estimates that, during 2023-2035, its preferred option ("primary proposal") will generate $55 billion in climate benefits, $13 billion in compliance costs, $7.2 billion in net compliance costs (i.e. $13 billion minus $5.5 billion in recovered product sales), and net benefits of $48 billion.[6] The proposal thus looks like an amazing deal, with climate benefits exceeding compliance costs by 4.2 to 1 or (factoring in product recoveries) 7.6 to 1. Upon inspection, however, those benefits are make-believe. The proposal would impose enormous costs for undetectably small benefits.

Near the end of the proposal, the EPA asserts that its climate-benefit calculations are not a factor influencing regulatory stringency: "However, we emphasize that the monetized benefits analysis is entirely distinct from the statutory BSER determinations proposed herein and is presented solely for the purposes of complying with E.O. 12866."[7]

Respectfully, that disclaimer does not shield the proposal from litigation risk. E.O. 12866 itself serves a more basic rule of reason. As the Supreme Court stated in its review of the Mercury Air Toxics Standards (MATS) rule in *Michigan v. EPA*: "One would not say that it is even rational, never mind 'appropriate,' to impose billions of dollars in economic costs in return for a few dollars in health or environmental benefits . . . No regulation is 'appropriate' if it does significantly more harm than good."[8]

The EPA's proposal is not reasonable if the climate benefits are illusory. An unreasonable regulation may be challenged as arbitrary and capricious.

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[6] RIA, Table 5-4, p. 5-7.

[7] 87 FR 74843. BSER stands for "best system of emission reduction." Clean Air Act section 111 performance standards are to reflect the degree of emission limitation achievable by the best system of emission reduction, taking into consideration cost, energy requirements, and non-air environmental impacts.

[8] *Michigan v. E.P.A.*, 576 U.S. 743, 752 (2015), https://supreme.justia.com/cases/federal/us/576/14-46/case.pdf.

II. Illusory Benefits

Reductions in climate-related damages, estimated at $55 billion, account for 100 percent of the proposal's monetized benefits. The vast majority of climate damages are attributed to the direct and indirect effects of global warming. How much warming would the proposal avert? Neither the proposal itself nor the accompanying RIA explicitly addresses that question.

However, other information in the RIA combined with EPA's climate policy model allows us to estimate the proposal's potential effects on global surface temperatures using the agency's own forecasting assumptions.

Table 1-3 Projected Emissions Reductions under the Primary Proposed NSPS OOOOb and EG OOOOc Option, 2023–2035

	Emissions Changes			
Proposal	**Methane (million short tons)**	**VOC (million short tons)**	**HAP (million short tons)**	**Methane (million metric tons CO_2 Eq. using GWP=25)**
NSPS OOOOb	6.1	1.8	0.07	140
EG OOOOc	35	10.0	0.41	790
Total	**41**	**12**	**0.48**	**920**

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted. To convert from short tons to metric tons, multiply the short tons by 0.907. Alternatively, to convert metric tons to short tons, multiply metric tons by 1.102.

The proposed standards are projected to eliminate 910 million metric tons (MMT) of carbon dioxide-equivalent (CO_2e) methane emissions during 2023-2035.[9] The EPA's Model for the Assessment of Greenhouse Gas Induced Climate Change, better known as MAGICC,[10] calculates the temperature effects of emission scenarios under different climate sensitivity assumptions. Climate sensitivity is a term used to describe how much warming results after the climate system fully adjusts to a doubling of CO_2e greenhouse gas concentration.

The proposal's reduction of 920 MMT CO_2e over 13 years averages about 71 MMT per year. In 2019, U.S. GHG emissions in CO_2e were about 6.6 billion metric tons.[11] A reduction of 71 MMT is about one-tenth of 1 percent of 2019 U.S. GHG emissions. Using MAGICC, we get the following predicted temperature reductions by 2050 and 2100:

- 4.5°C sensitivity, 0.005°C reduction by 2050, 0.014°C reduction by 2100
- 3.0°C sensitivity, 0.004°C reduction by 2050, 0.011°C by 2100
- 2.0°C sensitivity, 0.003°C reduction by 2050, 0.008°C by 2100[12]

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[9] RIA, Table 1-3, p. 1-10.
[10] https://magicc.org.
[11] EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2019.
[12] These estimates are linear extrapolations and not strictly correct because radiative forcing equations are logarithmic. Nonetheless, the calculations suffice as first order approximations.

For perspective, the standard deviation for measuring changes in global annual average surface temperature is 0.11°C.[13] Thus, the proposal's projected effects on global warming are undetectable. By the same token the proposal's potential effects on weather patterns, crop yields, coastal flooding, polar bear populations, and other climate-related environmental conditions would also be undetectable. Of greater policy relevance, such benefits are too small to be experienced by people and other living things.

Benefits that can neither be detected nor experienced are so in name only. Illusory "benefits" should not be weighed in the same scales with multi-billion-dollar compliance costs that verifiably impose measurable burdens on identifiable people and businesses.

III. Social Cost of Greenhouse Gases (SC-GHG): Too Speculative, and Too Easily Manipulated, to Inform Regulatory Decisions

Although the proposal's climate effects will make no discernible difference to the health and welfare of any human population or non-human species, the EPA values the associated methane emission reductions at $55 billion. The EPA's calculation is based on U.S. Government (USG) estimates of the social cost of methane (SC-CH_4).

The SC-CH_4 is a subset of the social cost of greenhouse gases (SC-GHG), which also includes the social cost of carbon dioxide (SC-CO_2) and social cost of nitrous oxide (SC-N_2O). The SC-GHG purports to be a present-dollar estimate of the cumulative damages caused by the emission of one ton of GHG emissions in a given year. By implication, the SC-GHG also purports to be a present-dollar estimate of the benefit of reducing GHG emissions by one ton.

The IWG uses three integrated assessment models (IAMs) to estimate SC-GHG values. IAMs "integrate" a climate model, which estimates the physical impacts of GHG emissions, with an economic model, which estimates the dollar value of climate change effects on agricultural productivity, consumption, property damages, and other economic variables. The three IAMs are abbreviated DICE (Dynamic Integrated Climate-Economy), FUND (Climate Framework for Uncertainty, Negotiation and Distribution), and PAGE (Policy Analysis of the Greenhouse Effect). The IWG uses the three models to estimate climate-related damages out to the year 2300.

The proposal's climate benefits are based on the "interim" SC-CH_4 estimates in the IWG's February 2021 Technical Support Document (TSD).[14] Although the EPA has separately published and invites comment on new SC-GHG estimates incorporating recent research,[15] the

[13] The standard deviation of the surface (land-ocean) temperature record is about 0.11 degrees C. See J. Hansen, et. al. 1999. GISS Analysis of Surface Temperature Change. *Journal of Geophysical Research*, Vol. 104, No. D24, 30,997-31,022, https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/1999JD900835.

[14] Interagency Working Group on the Social Cost of Greenhouse Gases, Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, February 2021, https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.

[15] 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

proposal's benefit calculations rely on the February 2021 TSD, which the agency considers "the most appropriate estimate of the SC-CH_4 until revised estimates have been developed reflecting the latest, peer-reviewed science."[16]

As a general observation, SC-GHG estimates are too speculative, and too easily manipulated for political purposes, to inform regulatory decisions. The IWG exercise is a prime example. Section IV discusses the IWG's methodological biases. Section V examines the IWG's SC-CH_4 estimates.

IV. IWG Biases

SC-GHG estimates are highly sensitive to the modeler's choice of inputs and assumptions. For example, when the FUND model is updated with empirical information regarding climate sensitivity and carbon dioxide fertilization,[17] the SCC drops to very low numbers with substantial probabilities of being negative through 2050.[18] A negative SC-CO_2 is another way of saying a net benefit. Note, those low and even negative SC-CO_2 values result even when FUND is run with the IWG's lowest discount rate (2.5%).

	FUND Model Average SC-CO2, agricultural component updated - Discount Rate – 2.5%			
	Roe Baker (2007)	**Lewis and Curry (2018)**	**Lewis and Curry (2018) + 15%**	**Lewis and Curry (2018) + 30%**
2020	$32.90	$3.78 / 0.46	$0.62 / 0.53	-$1.53 / 0.59
2030	$36.16	$4.69 / 0.44	$1.25 / 0.51	-$1.02 / 0.57
2040	$39.53	$5.76 / 0.42	$2.03 / 0.48	-$0.33 / 0.54
2050	$42.98	$6.98 / 0.39	$2.96 / 0.46	-$0.55 / 0.51

Figure Source: *Dayaratna et al. (2020). FUND model's CO_2-fertilization coefficients updated to increase agricultural benefits by 15 percent and 30 percent and run with the updated equilibrium estimate sensitivity (ECS) distribution of Lewis and Curry (2018).*[19]

Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances, September 2022, https://www.epa.gov/system/files/documents/2022-11/epa_scghg_report_draft_0.pdf (hereafter External Review Draft).

[16] 87 FR 74713.

[17] Rising CO_2 concentration enhances the growth of most food crops and other plant life by increasing their internal water use efficiency and photosynthetic activity. See Plant Growth Database, Center for the Study of Carbon Dioxide and Global Change, http://co2science.org/data/plant_growth/plantgrowth.php.

[18] Kevin Dayaratna, Ross McKitrick, and Patrick Michaels. 2020. Climate sensitivity, agricultural productivity and the social cost of carbon in FUND. Environmental Economics and Policy Studies 22: 433-448, https://link.springer.com/article/10.1007/s10018-020-00263-w (hereafter Dayaratna et al. (2020)).

[19] Lewis and Curry. 2018. The impact of recent forcing and ocean heat uptake data on estimates of climate sensitivity. *Journal of Climate* Vol. 31: 6051-6071, https://journals.ametsoc.org/view/journals/clim/31/15/jcli-d-17-0667.1.xml.

The last three columns show the mean SC-CO_2 as well as the associated probability of negative SCC values.

SC-GHG estimates are highly sensitive to:

- The discount rates chosen to calculate the present value of future emissions and reductions.

- The calculated climate sensitivities chosen to estimate the warming impact of projected increases in atmospheric GHG concentration.

- The timespan chosen to estimate cumulative damages from rising GHG concentration.

- The extent to which the SC-GHG reflects empirical information about the agricultural and ecological benefits of CO_2 fertilization.

- The assumptions chosen regarding the potential for adaptation to decrease the cost of future climate change impacts.

- The choice of socioeconomic pathways used to project future GHG emissions and concentrations.

In addition, from a political perspective, it matters whether the net benefits of climate policy proposals are calculated by comparing the domestic costs of GHG-reduction policies to IAM-estimated global climate benefits or the comparatively smaller domestic benefits.

Taken together, these considerations mean that if SC-GHG analysts wish to make climate change effects look economically catastrophic and build a case for aggressive regulation, they will:

- Run the IAMs with below-market discount rates, which inflates the perceived present value of future climate damages and emission reductions.[20]

- Use IAMs with climate sensitivity derived from general circulation models that, on average, project twice as much warming in the tropical troposphere as has been observed over the past 40-plus years.[21]

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[20] D. W. Kreutzer, "Discounting Climate Costs," Heritage Foundation Issue Brief No. 4575, June 16, 2016, https://www.heritage.org/environment/report/discounting-climate-costs; Kevin Dayaratna, Rachel Greszler and Patrick Tyrrell, "Is Social Security Worth Its Cost?" Heritage Foundation Backgrounder No. 3324, July 10, 2018, https://www.heritage.org/budget-and-spending/report/social-security-worth-its-cost.

[21] See, e.g., John R. Christy and Richard McNider. 2017. Satellite Bulk Tropospheric Temperatures as a Metric for Climate Sensitivity. *Asia-Pac. J. Atmos. Sci.*, 53(4), 511-518, https://wattsupwiththat.files.wordpress.com/2017/11/2017_christy_mcnider-1.pdf; R. McKitrick and J. Christy. 2018. A Test of the Tropical 200- to 300-hPa Warming Rate in Climate Models, *Earth Space and Science*, 5, 529–536, https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2018EA000401; and McKitrick and J. Christy. 2020. Pervasive Warming Bias in CMIP6 Tropospheric Layers. *Earth and Space Science*, 7, Issue 9, https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020EA001281.

- Calculate cumulative damages over a 300-year period—i.e., well beyond the limits of informed speculation about future economic vulnerabilities and adaptive technologies.

- Minimize the agricultural benefits of atmospheric CO_2 fertilization by, for example, averaging the results of three IAMs, two of which (DICE and PAGE) effectively assign a dollar value of zero to carbon dioxide's positive externalities.

- Include an IAM (PAGE) that unrealistically assumes adaptation cannot mitigate the cost of climate change impacts once 21st century warming and sea-level rise exceed 1°C and 10 inches, respectively,[22] and never acknowledge the ongoing declines in climate-related mortality and climate-related losses per exposed GDP.

- Run the models with implausible emissions scenarios that assume the world repeatedly burns through all economically recoverable fossil fuel reserves.[23]

- Inflate the perceived net benefits of climate policies to U.S. residents by comparing domestic costs (apples) to global benefits (oranges).

- Conceal those malpractices by ignoring any peer-reviewed studies that identify and challenge the aforementioned biases.[24]

In other words, if analysts want to stack the deck in favor of increasingly stringent GHG regulation, they would do exactly what the Obama IWG did in its 2010, 2013, and 2016 TSDs, and what the Biden IWG did in its 2021 interim TSD.

Arbitrary and Capricious: IWG Climate Sensitivity Assumptions

The key climate specification used in estimating the SC-GHG is the equilibrium climate sensitivity (ECS) distribution. Such distributions probabilistically quantify the earth's temperature response to a doubling of CO_2 concentrations. IAMs do not generate climate sensitivity estimates but rather use estimates from general circulation models (GCMs) and earth system model (ESMs) as inputs when calculating changes in global annual average temperatures and other climate variables.

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[22] Interagency Working Group, Technical Support Document: - Technical Update of the Social Cost of Carbon Under Executive Order 12866 - August 2016, pp. 14-15, https://www.epa.gov/sites/default/files/2016-12/documents/sc_co2_tsd_august_2016.pdf.

[23] Roger Pielke, Jr., "The Biden Administration Just Failed Its First Scientific Integrity Test," The Honest Broker, February 28, 2021, https://rogerpielkejr.substack.com/p/the-biden-administration-just-failed.

[24] For example, the 115 references listed at the end of the IWG's February 2021 TSD do not include either Dayaratna et al. (2020) or Kevin Dayaratna, Ross McKitrick, and David Kreutzer. 2017. Empirically Constrained Climate Sensitivity and the Social Cost of Carbon, *Climate Change Economics*, Vol. 8, No. 2 (2017), p. 1750006-1-1750006-12, https://www.worldscientific.com/doi/abs/10.1142/S2010007817500063. Similarly, those studies are not included among the 300-plus references listed in the EPA's September 2022 External Review Draft report.

The IWG's 2010, 2013, 2016, and 2021 TSDs use the ECS distribution from a study by Gerard Roe and Marcia Baker published 16 years ago in the journal *Science*.[25] This non-empirical distribution, calibrated by the IWG based on assumptions it selected in conjunction with IPCC recommendations,[26] is no longer scientifically defensible.

Since 2011, several empirically constrained distributions have been published in the peer-reviewed literature. Many of those distributions suggest lower probabilities of extreme global warming in response to CO_2 concentrations. The chart below[27] compares the sensitivity range and average of 24 empirically constrained studies to the Roe-Baker distribution and median of climate models used in the IPCC's Fifth Assessment Report (AR5).

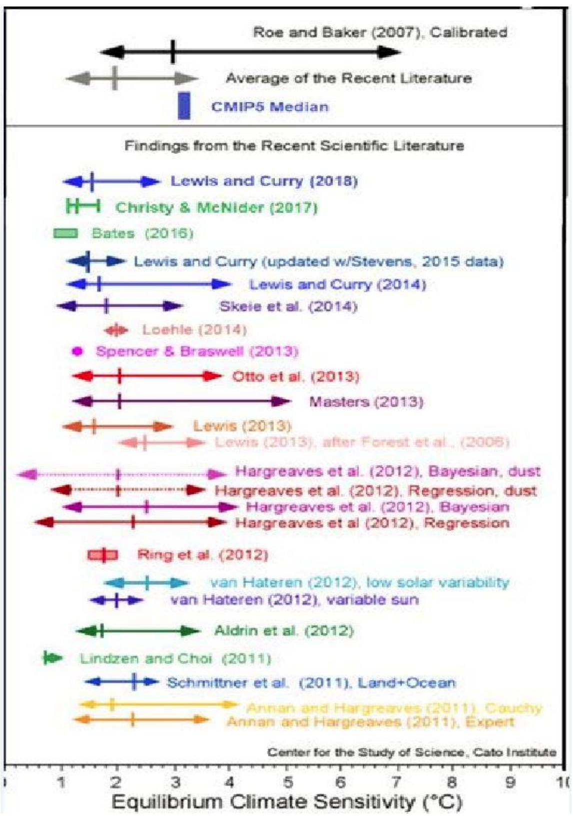

Figure Source: *Patrick J. Michaels and Ryan Maue, March 6, 2019.*

The next chart compares the probability of high-end warming in Roe-Baker to three prominent empirically constrained distributions:[28]

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[25] Gerard H. Roe and Marcia B. Baker. 2007. Why Is Climate Sensitivity So Unpredictable? *Science*, Vol. 318, No. 5850, pp. 629–632, https://science.sciencemag.org/content/318/5850/629.

[26] IWG, Technical Support Document: - Social Cost of Carbon for Regulatory Impact Analysis - Under Executive Order 12866, February 2010, pp. 13-14, https://www.epa.gov/sites/default/files/2016-12/documents/scc_tsd_2010.pdf (hereafter IWG, TSD 2010).

[28] Nicholas Lewis, "An Objective Bayesian Improved Approach for Applying Optimal Fingerprint Techniques to Estimate Climate Sensitivity," *Journal of Climate*, Vol. 26, No. 19 (October 2013), pp. 7414–7429, https://journals.ametsoc.org/view/journals/clim/26/19/jcli-d-12-00473.1.xml; Alexander Otto et al.,

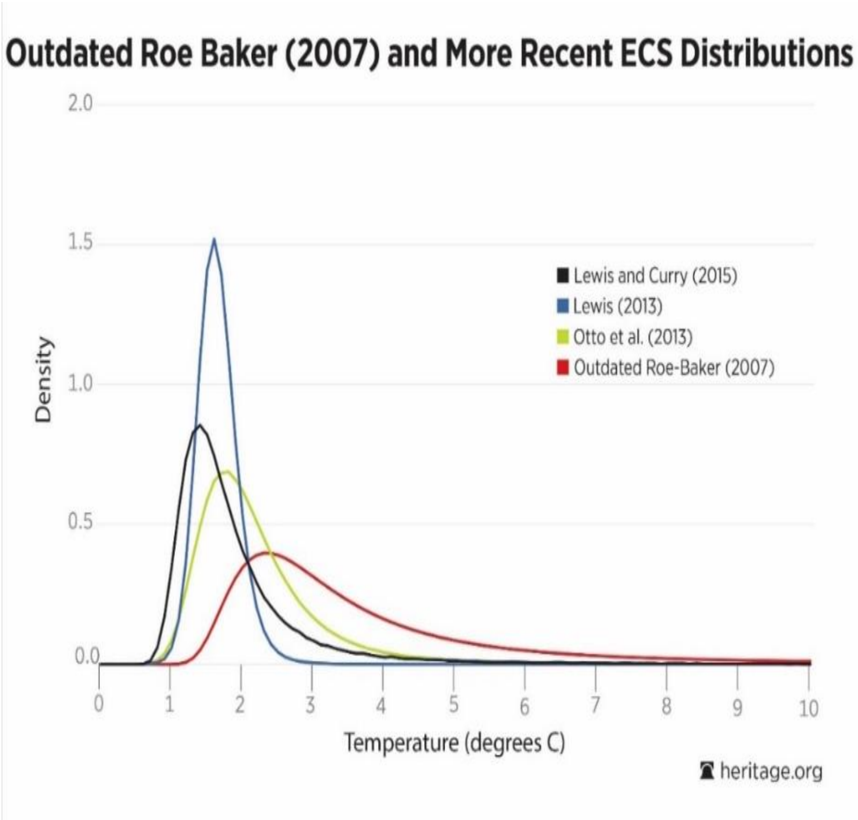

Figure Source: *Kevin D. Dayaratna, Heritage Foundation*

The areas under the curves between two temperature points represent the probability that the earth's temperature will increase between those amounts in response to a doubling of CO_2 concentration. For example, the area under the curve from 4°C onwards (known as right-hand "tail probability") represents the probability that the earth's temperature will warm by more than 4°C in response to doubled CO_2 concentration. Note that the more up-to-date ECS distributions (Otto et al., 2013; Lewis, 2013; Lewis and Curry, 2015) have significantly lower tail probabilities than the outdated Roe-Baker (2007) distribution used by the IWG.

One might suppose that an ECS distribution based on today's state-of-the-art GCMs and ESMs would be more realistic than the Roe-Baker ECS. Not so.

Even the latest generation of models—the CMIP6 ensemble used in the IPCC's Sixth Assessment Report (AR6)—overshoots observed warming in the tropical troposphere by at least a factor of two.

"Energy Budget Constraints on Climate Response," *Nature Geoscience*, Vol. 6, No. 6 (June 2013), pp. 415–416, https://www.nature.com/articles/ngeo1836; Nicholas Lewis and Judith A. Curry, "The Implications for Climate Sensitivity of AR5 Forcing and Heat Uptake Estimates," *Climate Dynamics*, Vol. 45, No. 3, pp. 1009–1923, http://link.springer.com/article/10.1007/s00382-014-2342-y.

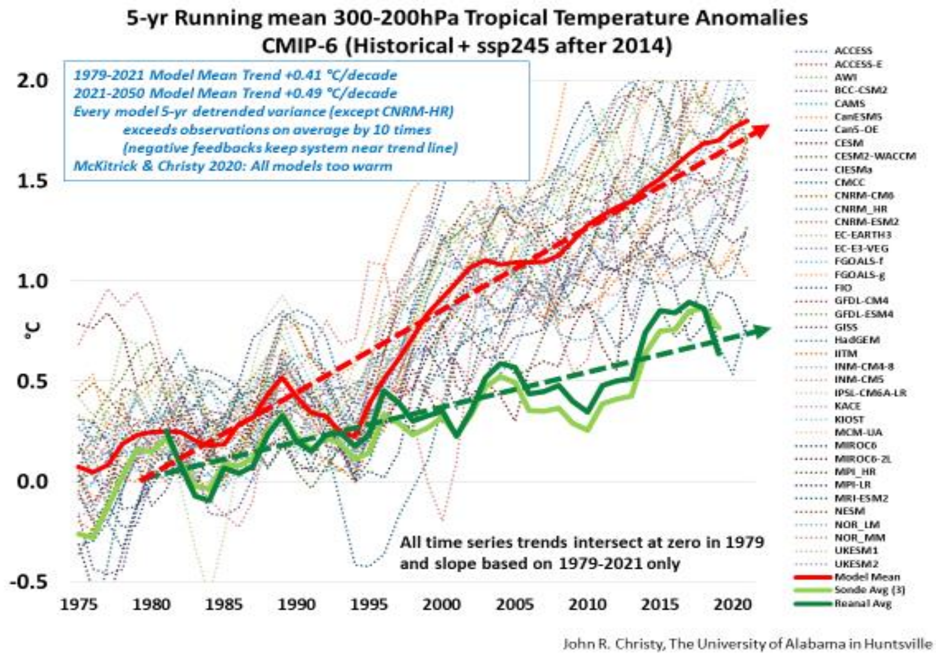

Figure Source: *John Christy*

Note that the tropical mid-troposphere is the only portion of the atmosphere where observations can test the validity of atmospheric warming predictions.[29] That is because: (1) all models predict a strong warming signal in that atmospheric layer; (2) the region is well-monitored by satellites and weather balloons; (3) the region is too high in altitude to be influenced by urban heat islands; and (4) the models have not been previously "tuned" to match tropical troposphere temperature data.

In a series of cases dealing with the EPA's modeling of air pollutant risks, the U.S. Court of Appeals for the D.C. Circuit Court has repeatedly held that an agency's use of a model is "arbitrary" if the model bears "no rational relationship to the reality it purports to represent."[30] The IWG relies on sensitivity estimates derived from models that are off by more than 100 percent in the atmospheric layer best suited to measure changes in the greenhouse effect. Errors of that magnitude earn failing grades in most academic disciplines. Much smaller errors can lead to disaster in fields of applied mathematics such as civil and aeronautical engineering.

The IWG's reliance on ECS distributions derived from models that significantly overshoot observed warming is not reasonable. Consequently, a rulemaking that depends on the IWG SC-GHG estimates for 100% of its monetized benefits may be challenged as arbitrary and capricious.

[29] McKitrick and Christy (2018).

[30] Chem. Mfrs. Ass'n v. EPA 28 F.3d 1259, 1264 (D.C. Cir. 1994); *Am. Iron & Steel Inst. v. EPA*, 115 F.3d 979, 1004 (D.C. Cir. 1997); *Columbia Falls Aluminum Co. v. EPA*, 139 F.3d 914, 923 (D.C. Cir. 1998); *Sierra Club v. EPA*, 356 F.3d 296, 307 (D.C. Cir. 2004).

Arbitrary and Capricious: Implausible Emissions Baselines

If it is arbitrary to rely on models that bear "no rational relationship to the reality" they purport to represent, it is equally arbitrary to rely on socioeconomic scenarios that egregiously overstate anticipated annual and cumulative emissions.

The core premise of SC-GHG analysis is that GHG emissions cause damaging climate change. Moreover, it is only in relation to a specific baseline emissions projection that the incremental damage of an additional ton of emissions can be calculated. For example, if GHG emissions were still at pre-industrial levels, there would be little or no anthropogenic warming and the SC-GHG would be zero—or strongly negative, reflecting the direct agricultural benefits of CO_2 fertilization. By the same token, if CO_2 emissions were still at pre-industrial levels but methane emissions somehow remained at historic levels, the overall anthropogenic greenhouse effect would be only one-third its current magnitude.[31] Consequently, IAM-estimated SC-CH_4 values would be much lower.

The IWG's continuing reliance of inflated emission baselines fatally compromises all its SC-GHG estimates. The 2010, 2013, 2016, and 2021 TSDs all rely on five emissions scenarios derived from a 2009 Stanford Energy Modeling Forum study known as EMF-22.[32] Table 4-6 below, from the Electric Power Research Institute's 2014 review of the IWG process, compares the IWG's five CO_2 emissions baselines to estimated global fossil-fuel reserves.[33]

As EPRI notes, all four of the no-policy scenarios (USG1-4 in the chart below) "result in post-2100 cumulative CO_2 emissions in excess of estimated fossil reserves." A fifth scenario (USG5) represents a future in which climate policies stabilize atmospheric CO_2 concentrations at 550 parts per million (ppm).

For computational purposes, the IWG assumed each of the five scenarios is equally likely to occur.[34] It is therefore the mean of the five baselines that supplies the CO_2 forcing input into the IAMs. The mean baseline in 2300 is 17,195 gigatons, which is 2.4 to 4.6 times larger than estimated global fossil reserves. As Roger Pielke, Jr. commented when the IGW released its February 2021 TSD, the IWG's SC-CO_2 values "envision cumulative carbon dioxide emissions that are far, far in excess of any plausible current expectation about the future." "In fact," he opined, "to even approach these massive amounts of cumulative emissions, the world would have to make it a policy goal to burn as much coal as possible over the coming centuries. That seems unlikely."

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[31] 87 FR 74720: "Indeed, one third of the warming due to GHGs that we are experiencing today is due to human emissions of methane. See 86 FR 63129 (November 15, 2021)."

[32] Leon Clarke et al. 2009. International climate policy architectures: Overview of the EMF 22 International Scenarios. *Energy Economics* Volume 31, Supplement 2, S64-S81, https://www.sciencedirect.com/science/article/pii/S0140988309001960?via%3Dihub.

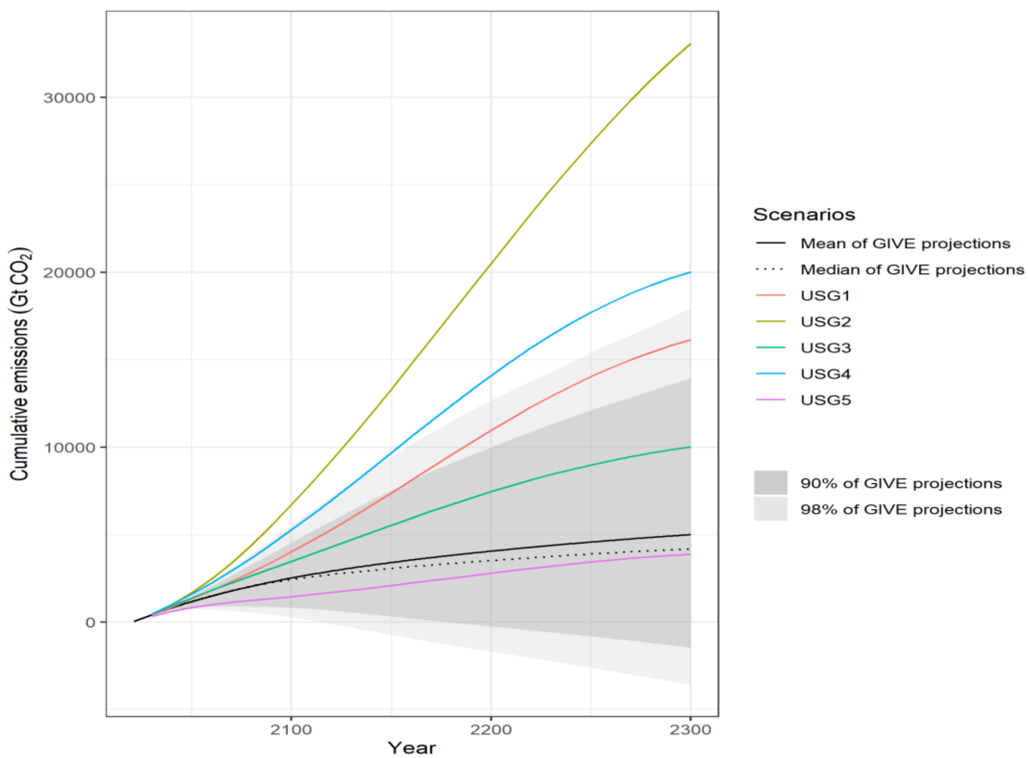
[33] EPRI, *Understanding the Social Cost of Carbon: A Technical Assessment*, October 2014, Section 4, pp. 3-4, https://www.epri.com/research/products/3002004657.

[34] EPRI, p. 4-1; IWG, 2010 TSD, p. 16.

Table 4-6
Cumulative fossil and industrial CO_2 emissions in the USG assumptions and estimated fossil fuel reserves

Cumulative CO_2 emissions ($GtCO_2$)		
	By 2200	By 2300
USG1	11,207	16,741
USG2	20,024	33,023
USG3	8,113	10,864
USG4	14,092	20,504
USG5	3,691	4,843
Estimated reserves ($GtCO_2$)	3,674 - 7,113	

That the USG baselines are unfit to drive social cost estimation is seldom acknowledged but no longer debatable. The EPA's September 2022 External Review Draft replaces the USG1-5 scenarios with socioeconomic projections (SPs) developed by Resources for the Future (RFF). The SPs are run with a new IAM called the Greenhouse Gas Impact Value Estimator (GIVE) model.[35] Cumulative CO_2 emissions in the GIVE mean and median emissions projections are only slightly higher than in the USG5 emission stabilization scenario.[36] In other words, the EPA is now projecting cumulative CO_2 emissions in 2300 will be about 5,000 Gt—less than one-third of the IWG's 17,195 Gt mean projection.



[35] Rennert et al. 2022. Comprehensive evidence implies a higher social cost of CO2. *Nature*, 610: 687-692, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9605864/.
[36] Chart courtesy of Kevin Rennert, December 2, 2022.

Figure Source: *Kevin Rennert, December 2, 2022. The mean and median projections of GIVE in 2300 are about 5,000 GtCO$_2$—roughly the USG5 500 ppm stabilization scenario. The USG1-5 mean of 17,195 GtCO$_2$ is more than three times higher.*

Before discussing another bias in the IWG process, we should raise a question about the EPA's External Review Draft, which aspires to transform official SC-GHG estimation. Why is the SC-CO$_2$ increasing when projected CO$_2$ emissions are decreasing? The following charts are from the 2021 TSD and the External Review Draft, respectively.[37]

Table ES-1: Social Cost of CO$_2$, 2020 – 2050 (in 2020 dollars per metric ton of CO$_2$)[3]

Emissions Year	Discount Rate and Statistic: 5% Average	3% Average	2.5% Average	3% 95th Percentile
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 3.1.1: Social Cost of Carbon (SC-CO$_2$) by Damage Module, 2020-2080 (in 2020 dollars per metric ton of CO$_2$)

	Near-Term Ramsey Discount Rate and Damage Module								
	2.5%			2.0%			1.5%		
Emission Year	DSCIM	GIVE	Meta-Analysis	DSCIM	GIVE	Meta-Analysis	DSCIM	GIVE	Meta-Analysis
2020	110	120	120	190	190	200	330	310	370
2030	140	150	150	230	220	240	390	350	420
2040	170	170	170	280	250	270	440	390	460
2050	210	200	200	330	290	310	500	430	520
2060	250	220	230	370	310	350	550	470	570
2070	280	240	250	410	340	380	600	490	610
2080	320	260	280	450	360	410	640	510	650

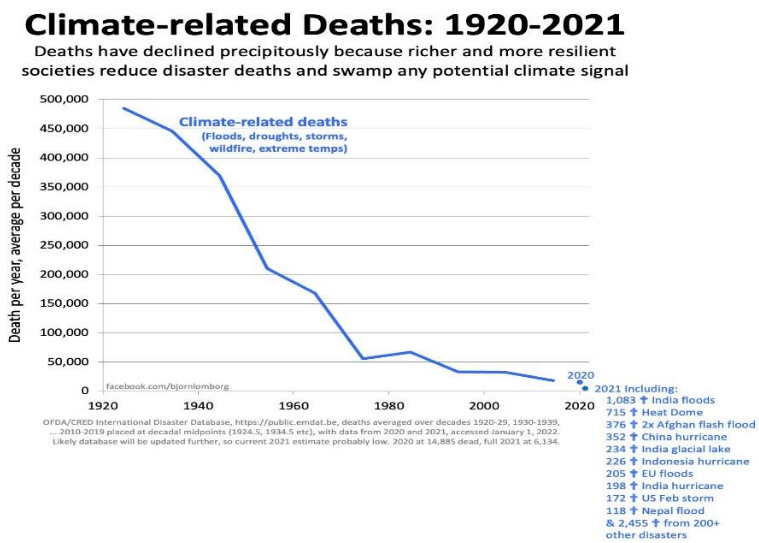
The central SC-CO$_2$ estimates in the External Review Draft are ~~$360-$450~~ $290-$330 per ton in ~~2080~~ 2050 compared to $85 per ton in the 2021 TSD. As noted, baseline CO$_2$ emissions in the External Review Draft are less than one-third those in the mean IWG projection. Yet the estimated damage predicted for an incremental ton of CO$_2$ in ~~2080~~ 2050 is ~~323% to 429%~~ more than three times higher. As with any paradox, this one calls out for explanation. Yet the External Draft Review does not even take note of it. The change in the central estimate discount rate from 3% to 2% is undoubtedly a factor. What else is involved?

[37] IWG, 2021 TSD, p. 5; External Review Draft, p. 67. [Note to readers: The comments as submitted mistakenly compared the IWG's 2050 SC-CO$_2$ estimates in Table ES-1 with the EPA's 2080 SC-CO$_2$ estimates in Table 3.1.1. The text has been corrected and now compares the two tables' 2050 SC-CO2 estimates.]

Arbitrary and Capricious: Lowballing Human Adaptive Capabilities

The EPA's proposed rule is part of President Biden's government-wide effort to address the "climate crisis."[38] If climate change were a global ecological and economic crisis, we would expect to find evidence of declining health and well-being over the past 50 to 70 years. Instead, we find dramatic improvements in global life expectancy,[39] per capita income,[40] food security,[41] crop yields,[42] and various health-related metrics.[43] Recent years have seen a surge in displaced persons and disease mortality, but the causes (war in Ukraine, COVID-19) had nothing to do with climate change.

Of particular relevance, the number of climate-related deaths per decade has declined by 96% since the 1920s.[44] This spectacular decrease in aggregate climate-related mortality occurred despite a fourfold increase in global population. The individual risk of dying from extreme weather events declined by 99.4% over the past 100 years—an impressive testament to human adaptive capability.[45]



Source: *Bjorn Lomborg.*[46]

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[38] 86 FR 63113.

[39] Our World in Data, Life Expectancy, https://ourworldindata.org/life-expectancy.

[40] Our World in Data, Economic Growth, https://ourworldindata.org/economic-growth.

[41] Our World in Data, Food Supply, https://ourworldindata.org/food-supply.

[42] Our World in Data, Crop Yields, https://ourworldindata.org/crop-yields.

[43] Our World in Data, Global Burden of Disease, https://ourworldindata.org/health-meta#burden-of-disease.

[44] Bjorn Lomborg, "We're Safer from Climate Disasters than Ever Before," *Wall Street Journal*, November 3, 2021, https://www.wsj.com/articles/climate-activists-disasters-fire-storms-deaths-change-cop26-glasgow-global-warming-11635973538; "Fewer and Fewer People Die from Climate-Related Disasters," Facebook, https://www.facebook.com/bjornlomborg/posts/475702943914714/.

[45] Bjorn Lomborg, "The risk of dying from climate-related disasters has declined precipitously." Twitter, January 1, 2023, https://twitter.com/BjornLomborg/status/1609568094447456259.

[46] Bjorn Lomborg Facebook Page, updating "Welfare in the 21st century: Increasing development, reducing inequality, the impact of climate change, and the cost of climate policies," *Technological Forecasting and Social Change*, July 2020, Vol. 156, https://www.sciencedirect.com/science/article/pii/S0040162520304157.

We often hear that the weather is becoming increasingly destructive. However, what matters in terms of sustainability is relative economic impact—climate-related damages as a share of GDP. Weather-related loss rates per exposed GDP declined nearly five-fold from 1980–1989 to 2007–2016.[47] That progress occurred in both low-middle and high-middle income countries, and with respect to all forms of damaging weather.

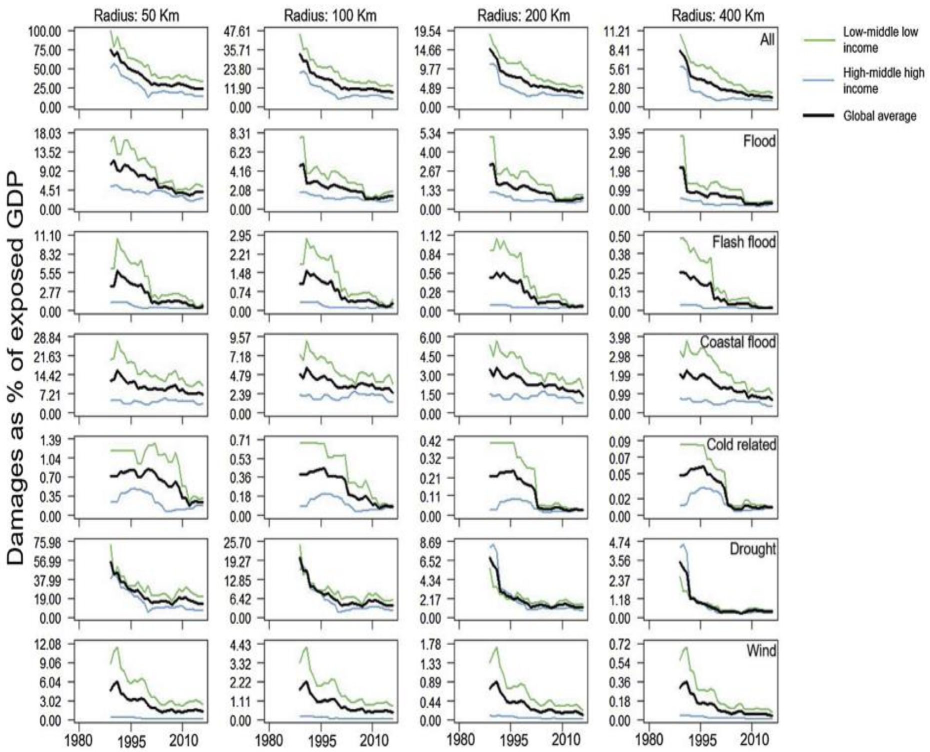


Fig. 3. Loss rates for the analyzed hazards. Results for each hazard represent 10-year moving average of the median (for each year per income class) loss rates for two income levels (low/middle-low income in green and high/middle-high income in blue) and all countries (average of low/middle-low and high/middle-high income classes). Multi-hazard loss rates are the sum of single hazard median values.

Source: *Formetta and Feyen (2019).*

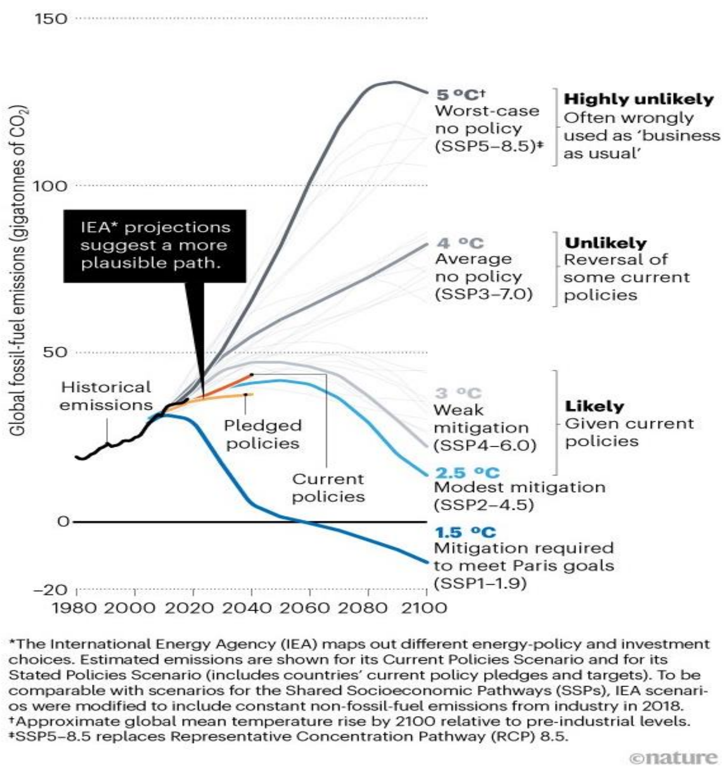
None of the IWG TSDs discuss or even acknowledge the dramatic declines in climate-related mortality risk and GDP loss rates.

One often hears that climate change is happening so fast it will soon overwhelm society's capacity to adapt. That is incorrect. The average warming rate in the global lower troposphere since the start of satellite monitoring in 1979 is a slow and steady 0.13°C per decade.[48] The

[47] Giuseppe Formetta and Luc Feyen. 2019. Empirical Evidence of Declining Global Vulnerability to Climate-Related Hazards, *Global Environmental Change*, 57: 1-9, https://www.researchgate.net/publication/333507964_Empirical_evidence_of_declining_global_vulnerability_to_climate-related_hazards.

[48] Roy Spencer, UAH Global Temperature Update for January, 2023: -0.04 deg. C, RoySpencer.Com, February 1, 2023, https://www.drroyspencer.com/2023/02/uah-global-temperature-update-for-january-2023-0-04-deg-c/.

RCP8.5 and SSP5-8.5 forcing scenarios[49] that underpin literally thousands of scary climate impact studies are no longer credible.[50] Those scenarios derive from earlier story lines that mistakenly assumed coal was destined to be the increasingly affordable backstop energy for the global economy.[51] For perspective, midcentury CO_2 emissions in the International Energy Agency's baseline emissions scenarios are less than half those projected in RCP8.5 and SSP5-8.5.[52]



Source: *Hausfather and Peters, 2020*.

As noted earlier, the PAGE model, one of the three IAMs used by the IWG to estimate SC-GHG values, assumes adaptation cannot mitigate the cost of climate change impacts once 21st century

[49] RCP stands for "Representative Concentration Pathway"; SSP stands for Shared Socioeconomic Pathway. In both RCP8.5 and SSP5-8.5, GHG concentrations in 2100 add 8.5 watts per square meter (W/m^2) of heat energy compared to the preindustrial climate.

[50] Roger Pielke, Jr. and Justin Ritchie, "How Climate Scenarios Lost Touch with Reality," Issues in Science & Technology, Vol. XXXVII, No. 4, Summary 2021, https://issues.org/climate-change-scenarios-lost-touch-reality-pielke-ritchie/. The authors note that, according to Google Scholar, "from the beginning of 2020 until mid-June 2021, authors published more than 8,500 papers using the implausible baseline scenarios, of which almost 7,200 use RCP8.5 and nearly 1,500 use SSP5-8.5."

[51] Justin Ritchie and Hadi Dowlatabadi, The 1,000 GtC Coal Question: Are Cases of High Future Coal Combustion Plausible? Resources for the Future, RFF DP 16-45, 2016, https://media.rff.org/documents/RFF-DP-16-45.pdf.

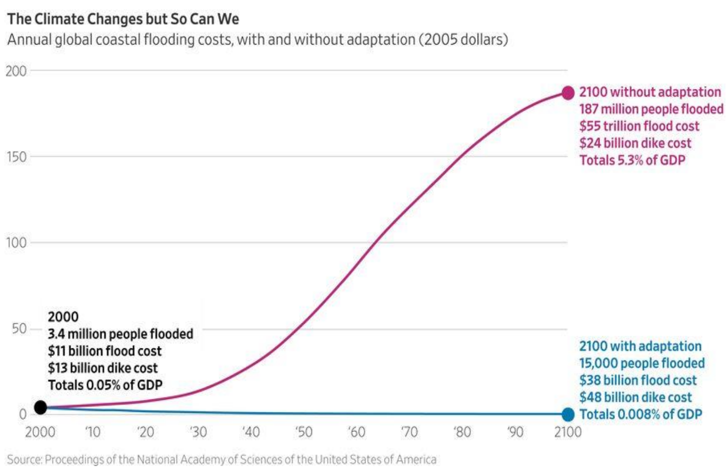
[52] Zeke Hausfather and Glenn P. Peters, "Emissions – the 'business as usual' story is misleading," Nature, January 29, 2020, https://www.nature.com/articles/d41586-020-00177-3.

warming and sea-level rise exceed 1°C and 10 inches, respectively.[53] Such pessimism is unreasonable.[54]

Even in the improbable worst case of an RCP8.5 warming that increases sea levels six feet by 2100, prudent adaptive measures could dramatically reduce the relative economic impact and number of flood victims to the point where people are much better off than they are today.[55]

As Bjorn Lomborg explains in his review of Hinkel et al. (2014), six feet of sea-level rise could cost $55 trillion (5.3% of GDP) or even $100 trillion (11% of global GDP) in 2100 if people do nothing more than maintain current sea defenses. But societies are unlikely to put up with ineffective protections year after year, decade after decade.

Here's what happens if societies invest in coastal protections to keep ahead of rising seas. Annual flood costs increase from $11 billion in 2000 to $38 billion in 2100. Similarly, annual dike costs increase from $13 billion to $48 billion. However, Lomborg notes, the global economic impact of coastal flooding actually declines from 0.05% of GDP to 0.008%. Moreover, the number of people experiencing coastal flood damages declines by more than 99%—from 3.4 million in 2000 to 15,000 in 2100.[56]



Source: *Bjorn Lomborg, adapted from Hinkel et al. (2014).*[57]

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[53] IWG, 2016 TSD, pp. 14-15.
[54] Bjorn Lomborg, "Climate Change Calls for Adaptation, Not Panic," *Wall Street Journal*, October 21, 2021, https://www.wsj.com/articles/climate-change-adaptation-panic-exaggerating-disaster-11634760376.
[55] Jochen Hinkel et al. 2014. Coastal flood damage and adaptation cost under 21st century sea-level rise. Proceedings of the National Academies of Sciences, 111(9):3292-7, https://www.researchgate.net/publication/260528772_Coastal_flood_damage_and_adaptation_cost_under_21st_century_sea-level_rise.
[56] Bjorn Lomborg, *False Alarm: How Climate Change Panic Costs Us Trillions, Hurts the Poor, and Fails to Fix the Planet* (New York: Basic Books, 2020), pp. 29-34, 185-186. In their study, Hinkel et al. state that enhanced adaptation can reduce flood damages from an RCP8.5 warming by "2-3 orders of magnitude." Lomborg's numbers for costs and flood victims come from charts in the study's supplementary material. See Hinkel et al. Supporting Information, https://www.pnas.org/content/pnas/suppl/2014/01/29/1222469111.DCSupplemental/pnas.201222469SI.pdf.
[57] Lomborg, Ibid., "Adaptation, not Panic."

Arbitrary and Capricious: Inflating the Perceived Benefits of GHG Reductions by Not Including a 7% Discount Rate

Changes in discount rates can massively affect the present value of future climate damages and mitigations. The lower the discount rate, the higher the present value of future costs and benefits, and vice versa. Under standard OMB accounting practices, agencies estimate future costs and benefits using discount rates of both 3% and 7%. The IWG uses rates of 2.5%, 3%, and 5%.

The reason to discount estimates of climate mitigation benefits at 7% is so that our regulatory policies will accurately reflect the predicted value of capital investments for comparison purposes. The long-term rate of return on the New York Stock Exchange is 7%. Discounting at 7% enables policymakers and the public to see how climate investments stack up against other investments potentially benefiting future generations.[58] At the very least, the IWG should have discounted climate benefits at 7% as a sensitivity case.

One of us (Dr. Dayaratna) and his former Heritage Foundation colleague David Kreutzer ran the DICE model with the IWG's three discount rates plus a 7% rate.[59] Here are the results:

TABLE 1

Average SCC Baseline, End Year 2300

Year	Discount Rate: 2.5%	Discount Rate: 3%	Discount Rate: 5%	Discount Rate: 7%
2010	$46.57	$30.04	$8.81	$4.02
2015	$52.35	$34.32	$10.61	$5.03
2020	$56.92	$37.79	$12.10	$5.87
2025	$61.48	$41.26	$13.60	$6.70
2030	$66.52	$45.14	$15.33	$7.70
2035	$71.57	$49.03	$17.06	$8.70
2040	$76.95	$53.25	$19.02	$9.85
2045	$82.34	$57.48	$20.97	$11.00
2050	$87.69	$61.72	$23.06	$12.25

Source: Calculations based on Heritage Foundation Monte Carlo simulation results using the DICE model. B 2860 heritage.org

Discounting at 7% significantly lowers the SC-CO_2. In 2050, the SC-CO_2 discounted at 7% is 47% lower than when discounted at 5% and 80% lower than when discounted at 3%. The IWG could easily have added a fourth column to its SC-CO_2 estimates. Not doing so unreasonably inflated the IWG's SC-CO_2 estimates.

[58] D. W. Kreutzer, "Discounting Climate Costs," Heritage Foundation *Issue Brief* No. 4575, June 16, 2016, https://www.heritage.org/environment/report/discounting-climate-costs; Kevin Dayaratna, Rachel Greszler and Patrick Tyrrell, "Is Social Security Worth Its Cost?" Heritage Foundation Backgrounder No. 3324, July 10, 2018, https://www.heritage.org/budget-and-spending/report/social-security-worth-its-cost.

[59] Dayaratna and Kreutzer, *Loaded DICE: An EPA Model Not Ready for the Big Game*, Backgrounder No. 2860, The Heritage Foundation, November 21, 2013, https://www.heritage.org/environment/report/loaded-dice-epa-model-not-ready-the-big-game.

Arbitrary and Capricious: Inflating the Perceived Benefits of GHG Reductions by Not Including a Shorter Analysis Period

Forecasting climate damages over a 300-year period is utterly fanciful. Nothing is harder to predict than technological change, and technology fundamentally affects both emissions levels and socioeconomic vulnerability to climatic conditions and events.

In the previously-mentioned study, Dayaratna and Kreutzer ran DICE with a shorter, albeit still unrealistic, time frame of 150 years. Here are the results ending in 2150:

TABLE 3

Average SCC, End Year 2150

Year	Discount Rate: 2.5%	Discount Rate: 3%	Discount Rate: 5%	Discount Rate: 7%
2010	\$36.78	\$26.01	\$8.66	\$4.01
2015	\$41.24	\$29.65	\$10.42	\$5.02
2020	\$44.41	\$32.38	\$11.85	\$5.85
2025	\$47.57	\$35.11	\$13.28	\$6.68
2030	\$50.82	\$38.00	\$14.92	\$7.67
2035	\$54.07	\$40.89	\$16.56	\$8.66
2040	\$57.17	\$43.79	\$18.36	\$9.79
2045	\$60.27	\$46.68	\$20.16	\$10.92
2050	\$62.81	\$49.20	\$22.00	\$12.13

Source: Calculations based on Heritage Foundation Monte Carlo simulation results using the DICE model. B 2860 heritage.org

Shortening the analysis period to 150 years decreases the IWG's central SC-CO_2 estimate for 2050 by 20%. Again, the IWG could easily have added a sensitivity case with a shorter time frame. Exclusive use of a 300-year time also unreasonably inflated the IWG's SC-CO_2 estimates.

Arbitrary and Capricious: Inflating the Perceived Benefits of GHG Regulations to Americans

The EPA defends the Obama and Biden administrations' practice of comparing domestic regulatory costs to global climate benefits, noting, for example, that international trade, investment, and tourism create "spillover pathways" that make other nations' problems our problems as well.[60] Whatever the merits of that argument, it does not alter the fact that Americans bear most of the costs of regulations on the U.S. gas industry while non-Americans reap most of the purported climate benefits asserted for the proposed rule.

However valid it may be to present an estimate of global climate benefits, those should be reported separately from estimated domestic benefits, as Office of Management and Budget Circular A-4 directs.[61] There is no scientific or ethical justification for hiding the comparatively smaller domestic benefits of U.S. climate regulations.

[60] RIA, p. 3-9.
[61] Office of Management and Budget, Regulatory Impact Analysis: A Primer, p. 5, https://www.reginfo.gov/public/jsp/Utilities/circular-a-4_regulatory-impact-analysis-a-primer.pdf.

Summing Up

The IWG's questionable and biased methodological choices undercut the credibility of its SC-GHG estimates. Reasonable alternative assumptions about climate sensitivity and CO_2 fertilization substantially drive down SC-CO_2 estimates, even pushing social cost values into negative territory. Replacing the obsolete return-to-coal baselines with realistic emissions scenarios would further decrease SC-GHG values. SC-GHG values would be smaller still if calculated with alternative inputs regarding adaptation, discounting, and analysis period. Presenting global climate benefits separately from domestic benefits would help Americans assess whether the benefits of GHG-reduction policies justify the costs.

V. Problems with the SC-CH4

Obsolete ECS, Missing 7% Discount Rate

In a 2017 Heritage Foundation study, Dr. Dayaratna and Nicolas Loris examined the social costs of methane and nitrous oxide as determined by the DICE model. Their study finds that "the EPA's estimates of these statistics are just as unreliable as its SC-CO_2 estimates."[62] That is hardly surprising since DICE uses the obsolete Roe-Baker ECS distribution and the IWG does not discount methane reduction benefits at 7%.

The chart below shows the probability of various warming projections when DICE is run with the Roe-Baker, Otto et al. (2013), and Lewis (2013) ECS distributions.

TABLE 1

Associated Probabilities of Three ECS Distributions from the Peer-Reviewed Literature

Probability of Temperature Exceeding ...	Outdated Roe-Baker (2007) Distribution	Otto et al. (2013) Distribution	Lewis (2013) Distribution
1.5°C	0.987	0.826	0.691
2.0°C	0.872	0.497	0.111
2.5°C	0.679	0.257	0.01
3.5°C	0.369	0.075	< 0.001
4.5°C	0.205	0.029	< 0.001
5.5°C	0.12	0.015	< 0.001
6.5°C	0.071	0.009	< 0.001

SOURCE: Authors' calculations based on Gerard Roe and Marcia Baker, "Why Is Climate Sensitivity So Unpredictable?" *Science*, Vol. 318, No. 5850 (October 2007), pp. 629–632; Nicholas Lewis, "An Objective Bayesian Improved Approach for Applying Optimal Fingerprint Techniques to Estimate Climate Sensitivity," *Journal of Climate*, Vol. 26, No. 19 (October 2013), pp. 7414–7429; and Alexander Otto et al., "Energy Budget Constraints on Climate Response," *Nature Geoscience*, Vol. 6, No. 6 (June 2013), pp. 415–416.

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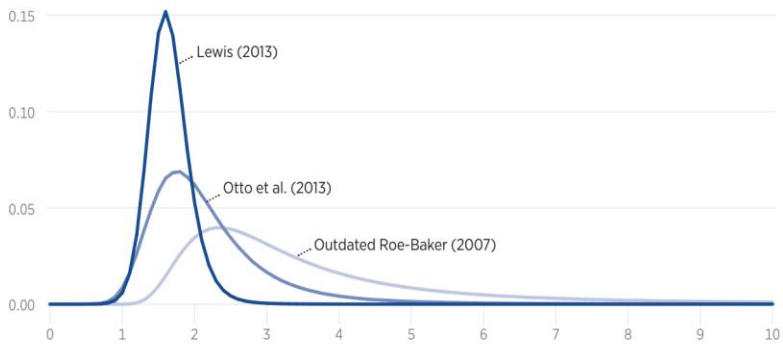
As the table above shows, the Roe–Baker distribution has significantly higher probabilities of extreme global warming than the other two ECS distributions entail. Roe-Baker predicts more warming and, consequently, higher SC-GHG values, including SC-CH_4 values.

[62] Kevin D. Dayaratna, PhD, and Nicolas D. Loris, Rolling the DICE on Environmental Regulations: A Close Look at the Social Cost of Methane and Nitrous Oxide, Heritage Foundation, Backgrounder No. 3184, January 19, 2017, https://www.heritage.org/sites/default/files/2017-01/BG3184.pdf.

Dayaratna and Loris present the same information graphically to show tail risk resulting from each ECS distribution:

CHART 1

Probability Density Functions of Outdated-Roe Baker (2007), Otto et al (2013), and Lewis (2013) ECS Distributions



SOURCE: Authors' approximations based on Gerard Roe and Marcia Baker, "Why Is Climate Sensitivity So Unpredictable?" *Science*, Vol. 318, No. 5850 (October 2007), pp. 629–632; Nicholas Lewis, "An Objective Bayesian Improved Approach for Applying Optimal Fingerprint Techniques to Estimate Climate Sensitivity," *Journal of Climate*, Vol. 26, No. 19 (October 2013), pp. 7414–7429; and Alexander Otto et al., "Energy Budget Constraints on Climate Response," *Nature Geoscience*, Vol. 6, No. 6 (June 2013), pp. 415–416.

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The authors next present tables on the SC-CH_4 and SC-N_2O showing the DICE model's sensitivity to changes in ECS distribution and discount rates.

TABLE 2

Social Cost of Methane, 2020

ECS Distribution	3%	7%
Roe-Baker	$932.08	$270.04
Otto et al.	$540.67	$184.01
Lewis	$360.33	$138.93

SOURCE: Calculations based on Heritage Foundation simulation results using the DICE model.

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TABLE 3

Social Cost of N_2O, 2020

ECS Distribution	3%	7%
Roe-Baker	$12,632.40	$1,882.21
Otto et al.	$7,570.67	$1,295.90
Lewis	$5,175.93	$988.68

SOURCE: Calculations based on Heritage Foundation simulation results using the DICE model.

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The study concludes:

> Using the Roe–Baker distribution and only the 3 percent discount rate, the DICE model calculates a $932.08 SC-$CH_4$ for the year 2020. However, using the more up-to-date distribution from Lewis and the 7 percent discount rate, the DICE model calculates a $138.93 SC-$CH_4$. Combined, these two reasonable changes cause the calculated value of the SC-CH_4 to drop by 85 percent.[63]

[63] Ibid.

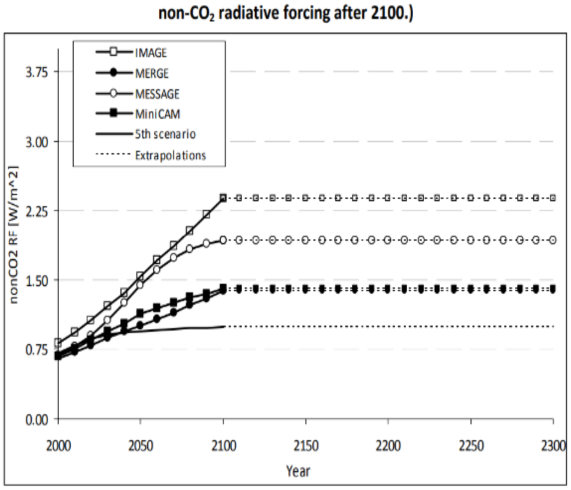
Inflated Methane Emission Baselines

EPRI (2014) does not present tonnage estimates of methane emissions in the USG1-5 scenarios as it does for CO_2 emissions in Table 4-6, shown above. Nonetheless, other information suggests the IWG's methane emission projections are significantly inflated.

The IWG's 2016 Addendum on the Social Cost of Methane and Nitrous Oxide[64] follows the methodology of Alex Marten, who himself follows the IWG 2010 TSD's procedure for projecting non-CO_2 GHG emissions. Originally, the five EMF-22 baselines ran from 2000 to 2100. The IWG extended those baselines out to 2300. It also assumed that whatever level of non-CO_2 GHG emissions the scenarios projected for 2100 would remain constant through 2300.[65] As EPRI put it, the five USG scenarios "Assume non-CO_2 radiative forcing is constant from 2100 to 2300 at 2100 levels."[66]

Figure A6 from the IWG's 2010 TSD depicts the five non-CO_2 GHG baselines:[67]

Figure A6. Global Non-CO_2 Radiative Forcing, 2000-2300 (Post-2100 extrapolations assume constant non-CO_2 radiative forcing after 2100.)



Note: In the fifth scenario, 2000-2100 emissions are equal to the average of the emissions under the 550 ppm CO2e, full-participation, not-to-exceed scenarios considered by each of the four models.

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[64] IWG, Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide, August 2016, pp. 2-3. https://eplanning.blm.gov/public_projects/1505255/200367210/20025472/250031676/Exhibit%2036_SCC%20Aug%202016%20Addendum.pdf.

[65] Alex L. Marten and Stephen C. Newbold, Estimating the Social Cost of Non-CO2 GHG Emissions: Methane and Nitrous Oxide, National Center for Environmental Economics, Working Paper # 11-01, January 2011, p. 8, https://www.epa.gov/sites/default/files/2014-12/documents/estimating_the_social_cost_of_non-co2_ghg_emissions_0.pdf.

[66] EPRI, p. 4-5.

[67] IWG, 2010 TSD, p. 47.

In EPRI's judgment, the extensions "raise a number of issues: inconsistency, likelihood, and uncertainty." We have already discussed the low likelihood of the CO_2 emission baselines and what EPRI calls "uncertainty"—the unpredictability of socioeconomic and emission trends over the "next 300 years." Equally telling is what EPRI says about "inconsistency":

> First, the USG extension approach results in inconsistency across variables. Specifically, the land-use CO_2 emissions and non-CO_2 radiative forcing extensions have no relationship in the USG design to the population, GDP, and fossil and industrial CO_2 emissions extensions, as well as each other. As a group, the extensions lack a coherent, viable, and intuitive storyline (or set of storylines) that drive all of the extensions from 2100 to 2300.[68]

Whatever else might be said about postulating constant non-CO_2 GHG emissions across five different scenarios over 200 years, it is not science or even an educated guess.

The key issue for present purposes, though, is how many million tons of methane emissions the five IWG scenarios project, and how realistic is the mean projection in light of more recent estimates, such as the RFF SPs.

None of the sources we examined—the IWG's 2010 TSD, the IWG's 2016 Addendum, Marten and Newbold (2011), EPRI (2014), Clarke et al. (2009), Rennert et al. (2021), or the EPA's September 2022 External Review Draft—provides tonnage estimates of methane emissions in the five IWG scenarios during 2000-2100 and 2100-2300.

The best we can do for now is compare Figure A6 from the 2010 TSD—or EPRI's color rendering of it—with Rennert et al.'s charts of CH_4 and N_2O emissions in the RFF SPs.

Here are the IWG's non-CO_2 GHG emission projections:

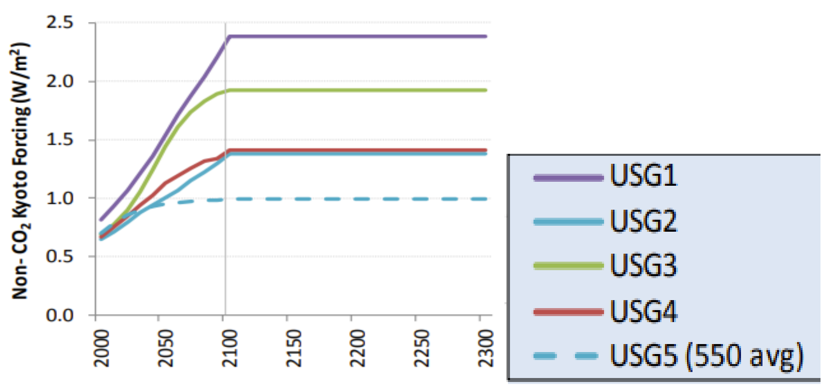


Figure Source: *EPRI (2014), p. 4-6.*

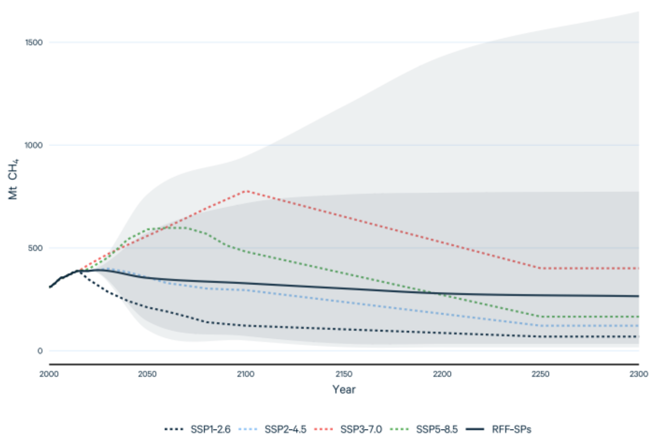
[68] EPRI, p. 4-14.

In USG1-4, non-CO_2 GHG emissions increase sharply during 2000 to 2100. Even in the USG5 stabilization scenario, emissions almost double during 2000-2100. As noted, emissions in all five scenarios hold constant after 2100.

The RFF SPs look quite different. Methane emissions peak about 2040 and gradually decline through 2150. Nitrous oxide emissions peak about 2050 and gradually decline through 2300.

5. CH_4 Emissions

Figure OA-9. Annual emissions of CH_4 from the RFF-SPs and the SSPs.



Lines represent median values, and dark and light shading represent the 5th to 95th (darker) and 1st to 99th (lighter) percentile ranges of the RFF-SPs.

6. N_2O emissions

Notes: Lines represent median values, and dark and light shading represent the 5th to 95th (darker) and 1st to 99th (lighter) percentile ranges of the RFF-SPs.

Figure Sources: *Rennert et al. 2021.*[69]

[69] Kevin Rennert et al. The Social Cost of Carbon: Advances in Long-Term Probabilistic

Without additional information, we cannot quantify the IWG's mean emission baselines for CH_4 and N_2O.[70] However, all five of the USG scenarios show significant increases in CH_4 and N_2O emissions during 2000-2100, after which emissions hold constant through 2300. In contrast, emissions decline after 2050 in the RFF-SP baselines, return almost to 2000 levels in 2100, and decline gradually after 2100. In short, the RFF SPs, which EPA considers the best baselines available, indicate that the IWG overestimated CH_4 emissions during the 2000-2300 analysis period. That, too, unreasonably inflates the SC-CH_4 values assumed in the proposed rule's climate benefit estimates.

To reiterate, the IWG's SC-CH_4 estimates are already arbitrarily inflated by the IWG's CO_2 emissions baseline, which biases upward the overall forcing from rising GHG concentration. NERA economist Anne Smith's discussion of the pivotal influence of GHG concentration in social cost computation is informative:

> The choice of socioeconomic scenario is important for the social cost computation because the scenario's assumptions regarding far-future emissions levels determine the amount of damage that the IAMs will attribute to a one-ton perturbation now. Damage curves are convex, meaning that at low levels of concentration, emissions pose little or no harm to the society, but as concentration increases, damage from emissions increases at an increasing rate. Thus, the higher the assumed future emissions, the higher the damage that ends up being assigned to a ton of emission today.[71]

VI. Conclusion

The EPA denies that its climate-benefits estimate based on the 2021 TSD's SC-CH_4 values had any role in determining the regulatory standards the agency proposes for the oil and gas sector. But those benefits constitute 100% of the proposal's monetized benefits. Moreover, those benefits are what the EPA relies on to conclude that the proposal's enormous regulatory expansion and multibillion-dollar compliance costs are reasonable and acceptable. Despite the EPA's protestation that its monetized benefit estimates are purely informational, those are a key assumption on which the rationality of the rulemaking depends.

As these comments show, the proposal's $55 billion climate-benefits estimate defies common sense because the proposal's physical effects on climatic conditions cannot be detected by scientists or experienced by people or other living things.

Projections of Population, GDP, Emissions, and Discount Rates, Online Appendix, October 2021, pp. 22-23, https://media.rff.org/documents/Rennert_et_al._BPEA_Appendix.pdf.

[70] Indeed, EPRI's chart does not separately estimate CH_4 and N_2O forcing. It also includes forcing from sulfur hexafluoride (SF_6). IWG, 2010 TSD, p. 40.

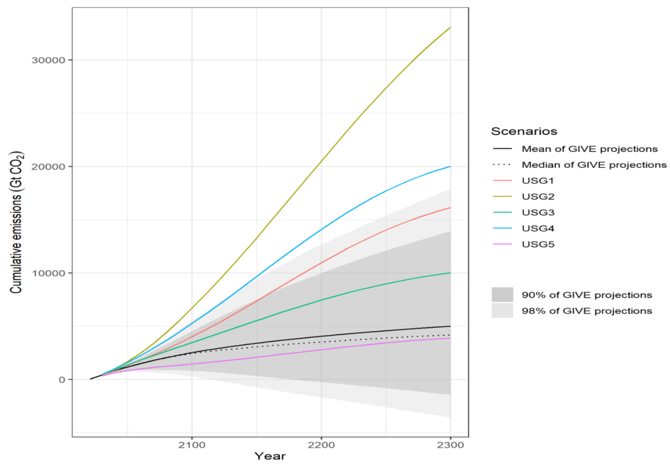
[71] Anne E. Smith, Technical Comments on the Social Cost of Methane As Used in the Regulatory Impact Analysis for the Proposed Emissions Standards for New and Modified Sources in the Oil and Natural Gas Sector, December 3, 2015, p. 20, https://www.nera.com/content/dam/nera/publications/2015/NERA_TechnicalComments_ProposedMethaneRegs_Dec3_FinalReport.pdf.

Those "benefits" are entirely an artifact of a methodology built on below-market discount rates, overheated climate models, inflated emissions baselines, IAMs that unreasonably ignore the agricultural benefits of CO_2 atmospheric enrichment, and an IAM that unreasonably depreciates mankind's proven ability to make Earth's naturally dangerous climate safer for human life and flourishing.

We therefore recommend that the EPA withdraw this proposal.

We also respectfully request that the EPA do two things in subsequent actions pertaining to SC-GHG analysis.

First, please produce charts like the one below that compare the IWG and RFF-SP emissions projections, but for CH_4 and N_2O emissions.



Second, please explain how, in the EPA's External Review Draft, the SC-CO_2 increases by factors of three to four despite a more than two-thirds decrease in projected CO_2 emissions during 2000-2300.

Sincerely,

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