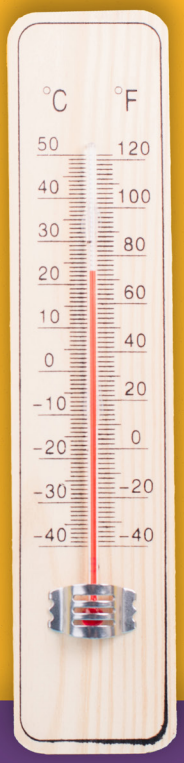
POLICY BRIEF



The Social Cost of Greenhouse Gases: An Overview

A Primer on EPA's Updated Values for Policymakers and Practitioners

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What is the Social Cost of Greenhouse Gases?

Climate change is already having and will continue to have severe consequences for society, including extreme weather, coastal destruction, and heat-related mortality. These damages from emitting greenhouse gases are high, but their costs are often overlooked in economic or policy decisions involving climate and energy.

The social cost of greenhouse gases (SC-GHG) is designed to solve this problem by quantifying and monetizing the cost of greenhouse gas emissions. Simply put, it's a monetary estimate of the damage done by each ton of greenhouse gases that is released into the air. It contains separate "social cost" values for several of the most common greenhouse gases, including:

Carbon Dioxide – CO_2 | **Methane – CH_4** | **Nitrous Oxide – N_2O**

The SC-GHG is a powerful tool that can streamline decisionmaking, and there are several advantages to using it in policy analysis. First, it captures many different climate impacts in a single metric. Second, the unit of that metric—dollars—facilitates simple comparison to other monetized effects, such as a policy's compliance cost. Third, the SC-GHG allows analysts to sum the effects of pollution emitted over multiple years into a single number, which is important because different greenhouse gases cause different damages depending on their year of emission. Fourth, the metric provides policymakers aiming to price greenhouse gases emissions (through fees or royalties, in procurement, or elsewhere) with a specific and scientific price. For these reasons, many decisionmakers—including policymakers in the federal government, numerous U.S. states, and some foreign nations—have long used the SC-GHG to craft smarter energy and climate policies.

In December 2023, EPA finalized updated values for the SC-GHG, following public comment and expert peer review.[1] The agency derived these estimates using the best available science and economics, and the estimates represent a significant step forward in our ability to properly value climate effects. As of now, these updated values are the most robust, scientifically-supported, and comprehensive climate-damage estimates currently available, and decisionmakers applying the SC-GHG should use EPA's Values.

BEST AVAILABLE ESTIMATE

$210

PER METRIC TON OF CO_2

2020$, for 2024 emissions at a 2% discount rate

History of the SC-GHG

Federal Court Decision Requires SC-GHG

A ruling by the U.S. Court of Appeals for the Ninth Circuit in 2007 required the federal government to account for the monetary effects of climate change in a regulatory impact analysis of vehicle fuel-efficiency standards.[4]

DICE Model Published

William Nordhaus first published his DICE model estimating the external cost of greenhouse gas pollution.[2] He would later win the Nobel Prize in Economics for this work.[3]

Interagency Working Group Convened

President Obama convened an Interagency Working Group (IWG) in 2009 to determine the appropriate social cost of carbon (SCC) value for use in federal analysis. The group released its first estimates, derived through a robust and scientifically-rigorous process, in 2010.[5]

IWG Updates Its Values

IWG Updates Its Values

The IWG also published damage estimates for other greenhouse gases at this time.[6]

National Academies Suggest Updates

The National Academies of Sciences completed a robust review of the SC-GHG calculation in two reports issued in 2016 and 2017.[7] Though largely endorsing the Working Group's approach, the National Academies also offered recommendations to update the metric.

EPA Releases Updated Values

In December 2023, the Environmental Protection Agency finalized updated values for the social cost of greenhouse gases following public comment and expert peer review.[8] EPA's updated values apply the 2017 recommendations of the National Academies. As detailed in this report, they are the most robust, scientifically-supported, and comprehensive climate-damage estimates currently available.

Court Rejects Trump Administration Values

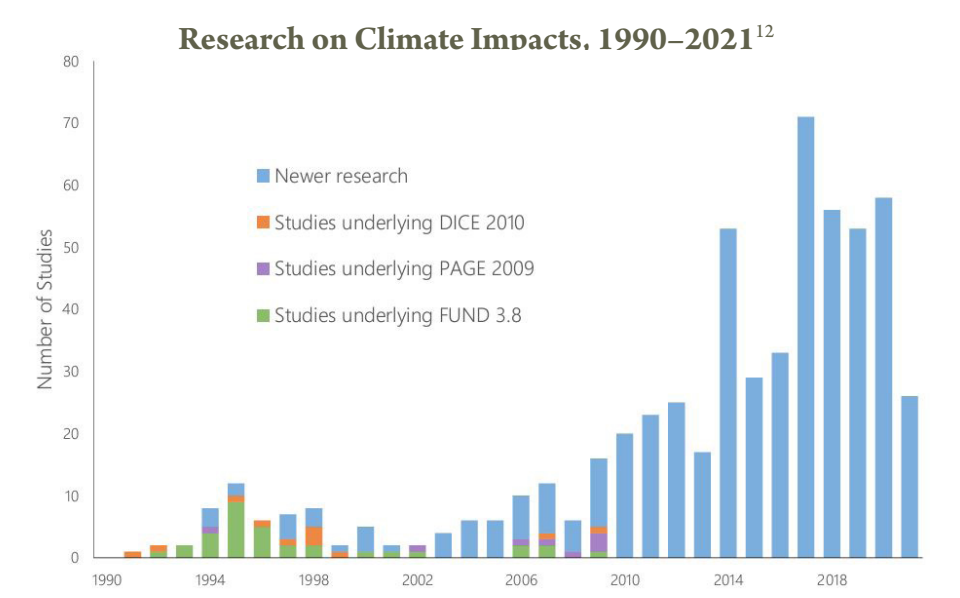
After the Trump administration began applying SC-GHG valuations that omitted all climate impacts originating beyond U.S. borders, a federal court rejected that approach as arbitrary and capricious.[9]

For these documents and others, see our online resources page.

Why EPA's SC-GHG Values Are the Most Robust Government Estimates

1. EPA's values rely on the latest studies and data.

EPA has explained that the "climate change literature and the science underlying the economic damage functions have evolved" since the Interagency Working Group's last substantive updates.[10] Specifically, the research underlying the Working Group's damage functions was published in the 1990s and 2000s, and many economic studies have been published since then.[11] EPA incorporated much of that newer research into its updated damage estimates. For instance, EPA used three state-of-the-art damage functions published within the past several years.



2. EPA's values are consistent with the latest research and federal guidance on discounting future impacts.

EPA's updated values apply the latest research on discounting and are the only federal valuations that are consistent with the Office of Management and Budget's (OMB) updated guidance on discounting in benefit-cost analysis. In November 2023, OMB finalized revisions to its Circular A-4 guidance document that endorsed a 2% discount rate.[13] As that document explains, economic evidence supports a near-term discount rate of 2%,[14] with the discount rate declining over time.[15] EPA's approach to discounting is consistent with this state-of-the-art guidance; EPA's central discount rate also starts at 2% and also declines over time, reflecting an approach with strong foundations in economic theory and literature.

3. EPA's values apply the National Academies' recommendations.

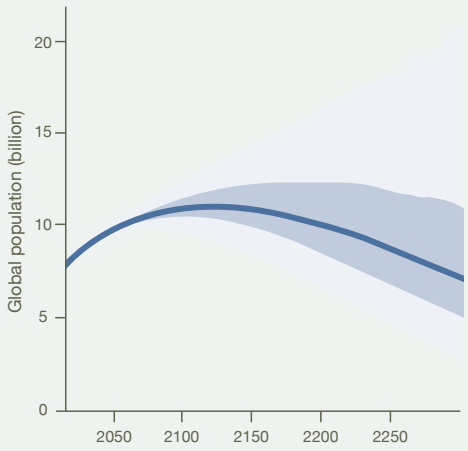
The National Academies largely endorsed the Working Group's approach but, in 2017, offered recommendations for improvement and called for future updates consistent with those recommendations.[16] EPA's update holistically incorporates those recommendations. For instance, EPA developed its climate-damage estimates through a four-step modular approach, following the National Academies' suggested framework.[17] Those four modules are outlined below.

How EPA Derives Its SC-GHG Estimates

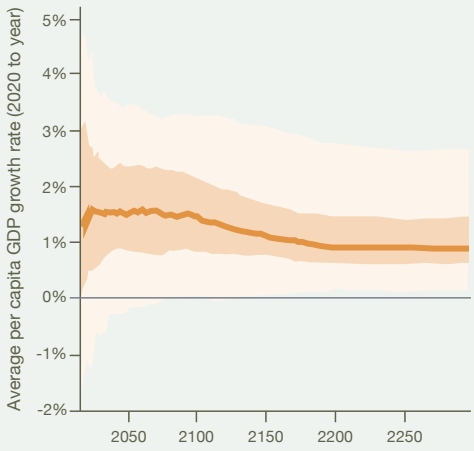
Step 1: Socioeconomic & Emissions Projections

First, cutting-edge models are used to estimate future trends in population, economic growth, and carbon emissions. These baseline trends are important to understand because factors like the population size and wealth will affect the value of total climate damages. Each trend was projected far into the future because the impacts of current emissions will last for centuries.[18]

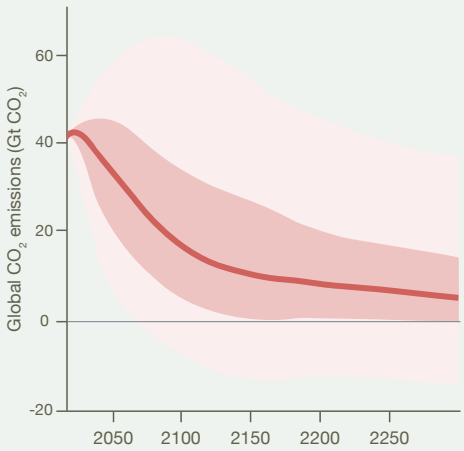
Population



Growth in GDP per capita



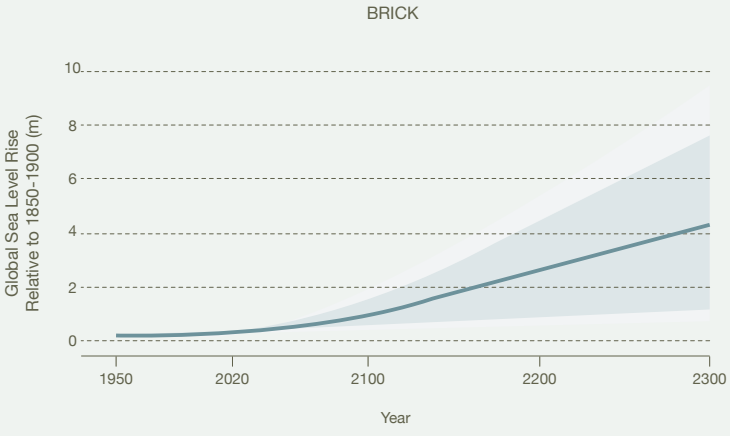
Global CO_2 emissions



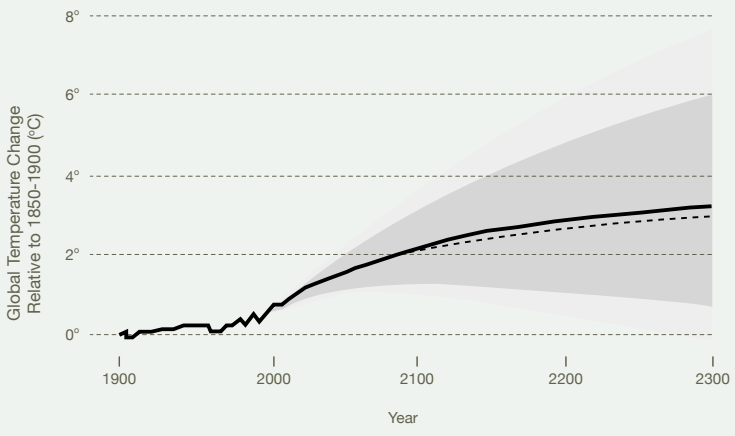
Step 2: Climate Projections

Next, the geophysical effects of climate effects caused by carbon emissions, such as sea-level and temperature increases, are estimated using leading scientific models. These effects will cause costly damage and therefore serve as inputs to the damage functions used in the next step.[19]

Sea Level Rise



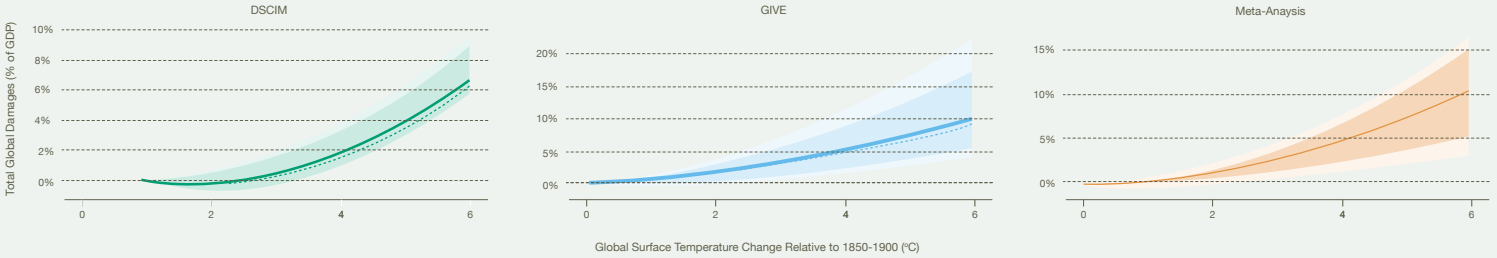
Temperature Rise



Step 3: Damage Functions

The damage functions are used to translate changes in temperature and other physical impacts of climate change into monetized estimates of net economic damages. They capture both some damages experienced through markets, like property damage from floods, and some non-market damages, like increased mortality. [20] The damage functions, however, omit many key climate change impacts, causing EPA's SC-GHG estimates to understate the true cost of climate change.[21]

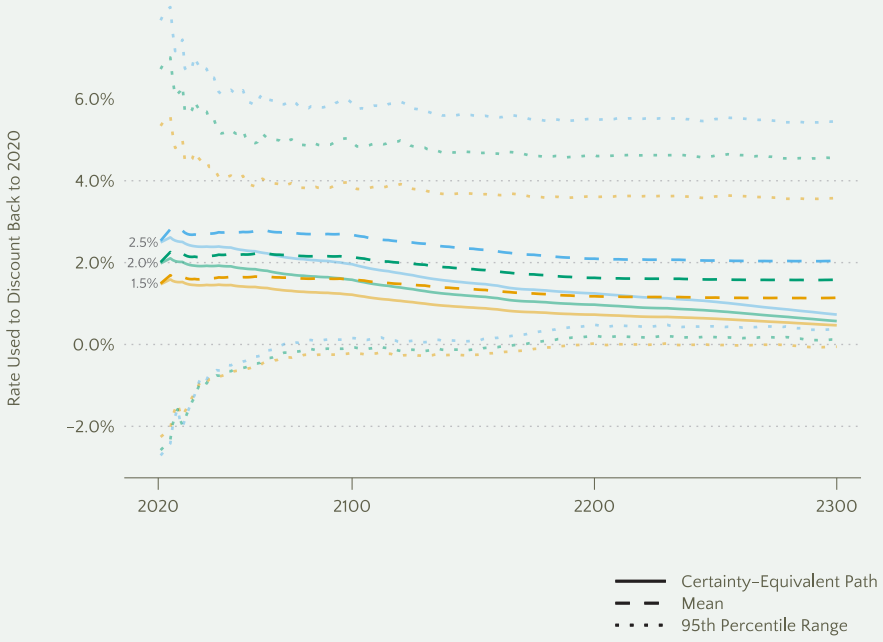
Annual Consumption Loss as a Fraction of Global GDP in 2100 Due to an Increase in Annual Global Mean Surface Temperature in the three Damage Modules



Step 4: Discounting

In economics, a discount rate is used to translate impacts that occur at different times into a common present value. EPA uses a central, near-term discount rate of 2% (with a range of 1.5% to 2.5%),[22] consistent with federal guidance[23] and economic consensus.[24] Under EPA's approach, the annual discount rate declines as effects get farther out in time.

Distribution of the Dynamic Discount Rates[25]



Expert Feedback on EPA's Updated Values

Expert Peer Reviewers

Report available here

[R]epresents a huge advance in estimating the US Social Cost of Carbon.[26]

Dr. Maureen Cropper, PhD
Professor of Economics, University of Maryland
Former Lead Economist, World Bank

It is… technically sound, responsive to a host of comments and inputs since the prior updates under the Obama administration, and generally represents well the emerging consensus in the literature.[28]

Dr. Gernot Wagner, PhD
Climate Economist, Columbia Business School

This is a much-needed improvement in estimating the social cost of carbon and greenhouse gas emissions.[27]

Dr. Catherine Louise Kling, PhD
Professor, Cornell University
Member, National Academy of Sciences

The update . . . is a significant step towards addressing the National Academies report in 2017 and continuing to improve the ability to assess the impact [of greenhouse gas emissions] on the United States.[29]

Dr. Chris E. Forest, PhD
Professor of Climate Dynamics, PennState University
Lead Author, IPCC Fifth Assessment Report

Other Expert Scientists and Economists

Letter available here

These updated estimates are a major, necessary step forward and yet are still likely conservative, as the EPA has noted.[30]

Letter signed by approximately 400 scientists and economists, including Nobel Laureate economist Dr. Eric Maskin, PhD

How the SC-GHG Is Used

The SC-GHG can be used at all levels of government to evaluate policies and guide decisions that affect greenhouse gas emissions, including:

- regulatory impact analysis for proposed and final rules
- environmental impact statements for energy projects
- resource management policy and royalty setting
- electricity regulation
- setting emissions caps
- procurement

Examples of Federal Government Uses

The **Environmental Protection Agency** uses the social cost of greenhouse gases to value the climate benefits of regulations that reduce greenhouse gas emissions from the vehicle, power, and oil-and-gas sectors, among others.[31] EPA uses those monetized values in its benefit-cost analyses to compare the rule's climate benefits to other monetized regulatory impacts.

The **Department of Energy** uses the social cost of greenhouse gases to value the climate benefits of regulations that improve the efficiency of home and commercial appliances such as lightbulbs, furnaces, and water heaters.[32] Like EPA, DOE uses those monetized benefit estimates in its benefit-cost analysis to help identify the regulatory alternative that maximizes net benefits.

The **Department of the Interior** uses the social cost of greenhouse gases to value the lifecycle climate impacts from fossil-fuel planning and leasing determinations.[33] For example, the Department's Bureau of Ocean Energy Management uses the SC-GHG to value the climate costs of offshore leasing in its benefit-cost analysis for five-year planning determinations.[34]

The **Council on Environmental Quality** advises agencies to account for climate impacts using the SC-GHG in environmental reviews under the National Environmental Policy Act.[35] For example, the U.S. Postal Service applied the SC-GHG (including EPA's updated values) in the environmental review of its recent procurement of a new fleet of mail trucks to assess the climate costs of different fleet options.[36]

The **Department of Transportation** requests that applicants to discretionary grant programs monetize the climate impacts of their grant proposals using EPA's updated SC-GHG values.[37] These monetized climate impacts can serve as a critical input in the applicant's benefit-cost analysis.

Examples of State Government Uses

New York uses the SC-GHG in calculating the climate benefits from emissions-free nuclear power under its "Zero Emissions Credit" program.[38]

Minnesota requires its Public Utilities Commission to use EPA's updated SC-GHG estimates for monetizing greenhouse gas emissions associated with electricity generation in Commission proceedings.[39]

Virginia requires its electric utility regulator to use the SC-GHG to assess the impacts of building fossil-fuel-fired generators.[40]

Vermont uses the SC-GHG to assess the climate benefits of its low-emission vehicle and zero-emission vehicle regulations.[41]

For more examples of state government uses, see here.

Examples of Foreign Government Uses

Germany uses its own SC-GHG in cost-benefit analysis of policies, regulations, and projects, including those meant to help achieve emissions reduction goals tied to the country's national climate change strategies.[42]

Canada adopted EPA's updated SC-GHG valuations in 2023, including the use of those valuations in the benefit-cost analysis of regulatory proposals.[43]

Frequently Asked Questions

Why do federal agencies and states use a global damages estimate?

EPA's values—like the IWG values—calculate the total damages from a ton of emissions, regardless of whether those damages occur inside or outside the United States. This is widely recognized as economically appropriate. Climate change is a global phenomenon, and emissions that occur in one region affect other regions. Valuing climate damages from a global perspective also facilitates international reciprocity that will benefit the United States. Additionally, many climate damages that begin in other countries can spill over into the United States through supply chains, disease vectors, migration, and international conflicts.[44] For further discussion of the appropriateness of a global estimate, see this report.[45]

What discount rates does EPA use?

EPA uses a central, near-term discount rate of 2% that declines over time.[46] This approach is consistent with economic best practices, as reflected in federal guidance. In fact, the federal Circular A-4 also endorses a near-term 2% rate that declines over time.[47] For further discussion, see this article.[48]

Is there too much uncertainty to use the SC-GHG?

Hardly. The presence of some uncertainty should not preclude agencies from using the damage estimates that are available.[49] Moreover, EPA rigorously considered uncertainty and accounted for it in numerous ways. While no valuation is perfect, valuing climate impacts using the best available science is far superior to not valuing them at all. For more discussion, see this report.[50]

Why are EPA's updated values higher than prior federal estimates?

EPA's valuations reflect the federal government's first comprehensive SC-GHG update since 2010. In that time, the science and economics around climate change have advanced, including through dozens of new peer-reviewed studies.[51] EPA comprehensively incorporated this new research in its updated SC-GHG calculations, and that resulted in a higher value.

Are EPA's values overestimates or underestimates?

EPA's values capture many climate damages, but also omit many damage categories and only partially incorporate others. For this reason, they are considered underestimates of total climate damages.[52] For a list of quantified and unquantified impacts, see this table.[53]

Appendix: Full Table of EPA's SC-GHG Values

Emission Year	SC-CO_2 (2020 dollars per metric ton of CO_2)			SC-CH_4 (2020 dollars per metric ton of CH_4)			SC-N_2O (2020 dollars per metric ton of N_2O)		
	Near-term rate			Near-term rate			Near-term rate		
	2.5%	2.0%	1.5%	2.5%	2.0%	1.5%	2.5%	2.0%	1.5%
2020	117	193	337	1,257	1,648	2,305	35,232	54,139	87,284
2021	119	197	341	1,324	1,723	2,391	36,180	55,364	88,869
2022	119	200	346	1,390	1,799	2,478	37,128	56,590	90,454
2023	125	204	351	1,457	1,874	2,564	38,076	57,816	92,040
2024	128	208	356	1,524	1,950	2,650	39,024	59,041	93,625
2025	130	212	360	1,590	2,025	2,737	39,972	60,267	95,210
2026	133	215	365	1,657	2,101	2,823	40,920	61,492	96,796
2027	136	219	370	1,724	2,176	2,910	96,796	62,718	98,381
2028	139	223	375	1,791	2,252	2,996	42,816	63,944	99,966
2029	141	226	380	1,857	2,327	3,083	43,764	65,169	101,552
2030	144	230	384	1,924	2,403	3,169	44,712	66,395	103,137
2031	147	234	389	2,002	2,490	3,270	45,693	67,645	104,727
2032	150	237	394	2,080	2,578	3,371	46,674	68,895	106,316
2033	153	241	398	2,157	2,666	3,471	47,655	70,145	107,906
2034	155	245	403	2,235	2,754	3,572	48,636	71,394	109,495
2035	158	248	408	2,313	2,842	3,673	49,617	72,644	111,085
2036	161	252	412	2,391	2,929	3,774	50,598	73,894	112,674
2037	164	256	417	2,468	3,017	3,875	51,578	75,144	114,264
2038	167	259	422	2,546	3,105	3,975	52,559	52,559	115,853
2039	170	263	426	2,624	3,193	4,076	115,853	77,644	117,443
2040	173	267	431	2,702	3,280	4,177	54,521	78,894	119,032
2041	176	271	436	2,786	3,375	4,285	55,632	80,304	120,809
2042	179	275	441	2,871	3,471	4,394	56,744	81,714	122,586
2043	182	279	446	2,955	3,566	4,502	57,855	83,124	124,362
2044	186	283	451	3,040	3,661	4,610	58,966	84,535	126,139
2045	189	287	456	3,124	3,756	4,718	60,078	85,945	127,916
2046	192	291	462	3,209	3,851	4,827	61,189	87,355	129,693
2047	195	296	467	3,293	3,946	4,935	62,301	88,765	131,469
2048	199	300	472	3,378	4,041	5,043	63,412	90,176	133,246
2049	202	304	477	3.462	4,136	5,151	64,523	91,586	135,023
2050	205	308	482	3,547	4,231	5,260	65,635	92,996	136,799

Endnotes

[1] Env't Prot. Agency, *EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances* (2023) (EPA Report).

[2] William D. Nordhaus, *The 'DICE' Model: Background and Structure of a Dynamic Integrated Climate-Economy Model of the Economics of Global Warming* (1992).

[3] The Nobel Prize, *William D. Nordhaus: Facts*, https://www.nobelprize.org/prizes/economic-sciences/2018/nordhaus/facts/ (2018).

[4] *Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin.*, 538 F.3d 1172, 1198–1203 (9th Cir. 2008). This opinion was first published in 2007; it was revised, for non-related reasons, in 2008.

[5] Interagency Working Grp. on Soc. Cost of Carbon, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis* 1 (2010).

[6] Starting in 2016, the IWG changed its name from the Interagency Working Group on the Social Cost of Carbon to the Interagency Working Group on the Social Cost of Greenhouse Gases.

[7] Nat'l Acads. of Scis., Eng'g & Med., *Assessment of Approaches to Updating the Social Cost of Carbon: Phase 1 Report on a Near-Term Update* (2016); Nat'l Acads. of Scis., Eng'g & Med., *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide* (2017).

[8] EPA Report, *supra* note 1.

[9] California v. Bernhardt, 472 F.Supp.3d 573, 611–12 (N.D. Cal. 2020).

[10] EPA Report, *supra* note 1, at 45–46. The Working Group released estimates of the social cost of methane and the social cost of nitrous oxide in 2016. In 2021, it endorsed its prior valuations for all three greenhouse gases and adjusted them for inflation.

[11] *Id.* at 46 fig.2.3.1.

[12] This chart is reproduced from *id.* at 46 fig.2.3.1.

[13] Off. of Mgmt. & Budget, Circular A-4: Regulatory Analysis 77 (2023) (Circular A-4).

[14] *Id.* at 76–77.

[15] *Id.* at 80.

[16] Nat'l Acads. of Scis., Eng'g & Med., Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide (2017).

[17] EPA Report, *supra* note 1, at 1.

[18] For more information on the socioeconomic and emissions module, see EPA Report, *supra* note 1, at 21–33.

[19] For more information on the climate module, see *id.* at 33–45.

[20] For more information on the damage module, see *id.* at 45–62.

[21] *See id.* at 87 tbl.3.2.1 (illustrating quantified, partially quantified, and unquantified impacts).

[22] For more information on the discounting module, see *id.* at 62–73.

[23] Federal interagency guidance on conducting benefit-cost analysis recommends the use of a 2% discount rate that declines over time. *See* Circular A-4, *supra* note 12, at 75–81.

[24] *See* Peter H. Howard et al., *U.S. Benefit-Cost Analysis Requires Revision*, 380 Science 803, 803 (2023) (co-authored with over a dozen economic experts on discount rates and concluding based on recent evidence and scholarship that the proper social discount rate is "close to 2%").

[25] EPA Report, *supra* note 1, at 72 fig.2.4.1.

[26] Env't Prot. Agency, *Details of External Peer Review Panel Process for the Review of EPA's "Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances"* 7 (2023).

[27] *Id.* at 10.

[28] *Id.* at 15.

[29] *Id.* at 9.

[30] Rachel Cleetus et al., Comment Letter on Report of the Social Cost of Greenhouse Gases (Feb. 13, 2023) (Docket ID No. EPA-HQ-OAR-2021-0317).

[31] For instance, EPA used its updated SC-GHG values to monetize the climate benefits of its recent regulation to reduce methane emissions from the oil and gas sector. *See* Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 89 Fed. Reg. 16,820, 17,018–19 (Mar. 8, 2024).

[32] For instance, DOE used the SC-GHG to monetize the climate benefits of its recent regulation to improve the efficiency of consumer furnaces. Energy Conservation Program: Energy Conservation Standards for Consumer Furnaces, 88 Fed. Reg. 87,502, 87,504–06 (Dec. 18, 2023).

[33] *See, e.g.*, Dep't of the Interior Order No. 3399 § 5(b) (Apr. 16, 2021) (recognizing the social cost of carbon as "a useful measure" for actions "in addition to rulemakings" that is "relevant to the choice among different [project] alternatives").

[34] *See* Bureau of Ocean Energy Mgmt., 2024–2029 National Outer Continental Shelf Oil and Gas Leasing Proposed Final Program 5-18, 5-24 to -25 (2023).

[35] National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change, 87 Fed. Reg. 1196, 1202–03 (Jan. 9, 2023) (NEPA Greenhouse Gas Guidance).

[36] U.S. Postal Service, Final Supplemental Environmental Impact Statement United States Postal Service Next Generation Delivery Vehicle Acquisitions v, 4-24 (Sept. 2023) (using EPA's updated valuations in addition to Interagency Working Group estimates).

[37] Dep't of Transp., Benefit-Cost Analysis Guidance for Discretionary Grant Programs 43 (Dec. 2023).

[38] New York Incorporates SCC Into Proceeding on Reforming the Energy Vision, CostOfCarbon, https://costofcarbon.org/states/entry/new-york-incorporates-scc-into-proceeding-on-reforming-the-energy-vision (Oct. 2018).

[39] Minnesota Law Requires Public Utilities Commission to Use EPA's Updated SC-GHG Values, CostOfCarbon, https://costofcarbon.org/states/entry/minnesota-law-requires-public-utilities-commission-to-use-epas-updated-sc-ghg-values (Feb. 2023).

[40] Virginia Passes Bill to Require Use of Social Cost of Carbon, CostOfCarbon, https://costofcarbon.org/states/entry/virginia-passes-bill-to-require-use-of-social-cost-of-carbon (Apr. 2020).

[41] Vermont Applies Social Cost of Carbon in Regulations for Low-Emission and Zero-Emission Vehicles, CostOfCarbon, https://costofcarbon.org/states/entry/vermont-applies-social-cost-of-carbon-in-regulations-for-low-emission-and-zero-emission-vehicles (Dec. 2022).

[42] U.S. Gov't Accountability Off., *Social Cost of Carbon: Identifying a Federal Entity to Address the National Academies' Recommendations Could Strengthen Regulatory Analysis* 40–43 (2020).

[43] Social Cost of Greenhouse Gas Estimates—Interim Updated Guidance for the Government of Canada, Government of Canada, https://perma.cc/3ZFW-T89K (last modified Apr. 20, 2023).

[44] For more discussion of EPA's choice of a global damages estimate, *see* EPA Report, *supra* note 1, at 12–19.

[45] Jason Schwartz, Inst. for Pol'y Integrity, *Strategically Estimating Climate Pollution Costs in a Global Environment* (2021).

[46] For more information on EPA's use of discounting, EPA Report, *supra* note 1, at 62–73.

[47] Circular A-4, *supra* note 12, at 75–81.

[46] Peter Howard & Jason Schwartz, Inst. for Pol'y Integrity, *About Time: Recalibrating the Discount Rate for the Social Cost of Greenhouse Gases* (2021).

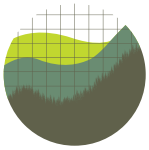
[49] *E.g.* Pub. Citizen v. Fed. Motor Carrier Safety Admin., 374 F.3d 1209, 1221 (D.C. Cir. 2004) ("Regulators by nature work under conditions of serious uncertainty, and regulation would be at an end if uncertainty alone were an excuse to ignore" the issue); Mont. Wilderness Ass'n v. McAllister, 666 F.3d 549, 559 (9th Cir. 2011) (noting that "[a]gencies are often called upon to confront difficult administrative problems armed with imperfect data" and must "do the best it can with the data it has"). *See also* Wis. Pub. Power, Inc. v. FERC, 493 F.3d 239, 260 (D.C. Cir. 2007) ("It is well established that an agency's predictive judgments about areas that are within the agency's field of discretion and expertise are entitled to particularly deferential review, as long as they are reasonable.") (internal quotation marks omitted).

[50] Iliana Paul & Max Sarinsky, Inst. for Pol'y Integrity, *Playing With Fire: Responding to Criticism of the Social Cost of Greenhouse Gases* 8–10 (2021) (describing legal standards for uncertainty and explaining that uncertainty leads to higher climate-damage valuations).

[51] EPA Report, *supra* note 1, at 46 tbl.2.3.1 (showing surge in new data since Interagency Working Group estimates).

[52] *Id.* at 81 ("There are still many important categories of climate impacts and associated damages that are not yet reflected in these estimates due to data and modeling limitations."); *id.* at 105 (noting that EPA's estimates "likely underestimate the marginal damages from greenhouse gas pollution").

[53] *Id.* at 87 tbl.3.2.1 (illustrating quantified, partially quantified, and unquantified impacts).



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