Government of Canada / Gouvernement du Canada

Social cost of greenhouse gas emissions

Official title: Social Cost of Greenhouse Gas Estimates – Interim Updated Guidance for the Government of Canada

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1. Introduction

The social cost of greenhouse gas (SC-GHG) estimates include: the social cost of carbon (SCC), the social cost of methane (SCM), and the social cost of nitrous oxide (SCN). Each SC-GHG is a measure of the incremental additional damages that are expected from a small increase in emissions of a given GHG (or conversely, the avoided damages from a decrease in emissions).

In Canada, SC-GHG estimates have been used since 2010 to value expected changes in GHG emissions as part of cost-benefit analysis (CBA) of regulatory proposals. More generally, these estimates are appropriate to use whenever weighing a decision that would lead to changes in GHG emissions, such as in the context of federal impact assessments for major projects.

While there are three separate estimates, one for carbon dioxide, methane, and nitrous oxide, often they are referred to as the "Social Cost of Carbon" or "SCC" in place of SC-GHG.

Canada's Strengthened Climate Plan, *A Healthy Environment and a Healthy Economy*, outlined ECCC's plans to update the SC-GHG estimates to reflect the latest science and economics.

This document updates the 2016 Technical Update to Environment and Climate Change Canada's Social Cost of Greenhouse Gas Estimates. It includes the interim updates to SC-GHG values that took effect for federal departments and agencies on December 12, 2022. It provides user-friendly guidance on how to apply SC-GHG estimates when informing decision-makers about the GHG impacts of a proposed policy, regulation, or project. This document will be kept "evergreen" and updated as the science of SC-GHG estimation continues to evolve.

The updated estimates herein are identical to those adopted by the U.S. EPA in their draft technical update, converted to Canadian currency in constant 2021 dollars. The U.S. EPA's draft guidance is undergoing review by an external expert peer-review panel into spring 2023, witha formal update to U.S. EPA guidance anticipated by fall 2023 or winter 2024.

The SC-GHG estimates include damages from a variety of climate change impacts, including, but not limited to, changes in net agricultural productivity, human health effects, property damage from increased flood risk, disruption of energy systems, and the value of ecosystem services. Given that climate change damages are a function of the cumulative stock of GHG emissions, the SC-GHG estimates increase over time as GHG emissions accumulate in the atmosphere. The SC-GHGs increase over time because: a) there are larger incremental damages from future emissions as physical and economic systems become more stressed from greater climatic change, and b) income grows over time, meaning future impacts affect more wealth, and as income grows there is a higher willingness to pay to avoid economic damages.

Importantly, even the most recent SC-GHG methodology provides conservative estimates of the impacts of incremental greenhouse gas emissions. This is because the scope of climate science, impacts, and damages included in the estimates do not capture some significant but difficult to model effects, such as extreme weather events, ocean acidification, national security risks, and interactions/feedbacks across sectors.

Table 1 below presents annual SC-GHG estimates for use by Government of Canada departments and agencies, effective December 12, 2022.

Annual SC-CO_2, SC-CH_4, and SC-N_2O values, 2020-2080, C$2021, 2% Near-term Ramsey discount rate

Table 1: Updated SC-GHG estimates (C$2021, $/tonne of respective GHG)

Year	SCC/SC-CO_2	SCM/SC-CH_4	SCN/SC-N_2O
2020	$247	$2,107	$69,230
2021	$252	$2,203	$70,797
2022	$256	$2,300	$72,364
2023	$261	$2,396	$73,932
2024	$266	$2,494	$75,499
2025	$271	$2,589	$77,066
2026	$275	$2,687	$78,633
2027	$280	$2,783	$80,201
2028	$285	$2,880	$81,768
2029	$289	$2,976	$83,335
2030	$294	$3,073	$84,903
2031	$299	$3,184	$86,501
2032	$303	$3,297	$88,099
2033	$308	$3,409	$89,698
2034	$313	$3,522	$91,295
2035	$317	$3,634	$92,894
2036	$322	$3,745	$94,492

Year	SCC/SC-CO_2	SCM/SC-CH_4	SCN/SC-N_2O
2037	$327	$3,858	$96,090
2038	$331	$3,971	$97,689
2039	$336	$4,083	$99,287
2040	$341	$4,194	$100,886
2041	$347	$4,316	$102,689
2042	$352	$4,439	$104,492
2043	$357	$4,560	$106,295
2044	$362	$4,682	$108,099
2045	$367	$4,803	$109,902
2046	$372	$4,924	$111,705
2047	$379	$5,046	$113,508
2048	$384	$5,167	$115,313
2049	$389	$5,289	$117,116
2050	$394	$5,410	$118,919
2051	$399	$5,524	$120,610
2052	$403	$5,638	$122,302
2053	$408	$5,751	$123,994
2054	$413	$5,864	$125,686
2055	$417	$5,978	$127,379
2056	$422	$6,091	$129,071

Year	SCC/SC-CO_2	SCM/SC-CH_4	SCN/SC-N_2O
2057	$427	$6,204	$130,762
2058	$432	$6,318	$132,454
2059	$436	$6,431	$134,146
2060	$441	$6,545	$135,838
2061	$445	$6,648	$137,319
2062	$449	$6,752	$138,798
2063	$453	$6,855	$140,279
2064	$457	$6,959	$141,758
2065	$460	$7,063	$143,239
2066	$464	$7,166	$144,719
2067	$468	$7,270	$146,199
2068	$472	$7,372	$147,679
2069	$476	$7,476	$149,160
2070	$480	$7,579	$150,639
2071	$483	$7,689	$152,206
2072	$488	$7,799	$153,772
2073	$492	$7,908	$155,339
2074	$496	$8,018	$156,905
2075	$500	$8,126	$158,470
2076	$504	$8,236	$160,037

Year	SCC/SC-CO_2	SCM/SC-CH_4	SCN/SC-N_2O
2077	$509	$8,346	$161,603
2078	$513	$8,455	$163,170
2079	$517	$8,565	$164,736
2080	$520	$8,674	$166,301

For the remainder of the report, Section 2 provides guidance on how to apply these estimates in practice. Section 3 gives further information on how these estimates were derived. Section 4 answers frequently asked questions. Section 5 outlines how they will be updated going forward. Lastly, the Appendix provides additional tables of annual SC-GHG estimates for use in sensitivity analysis.

2. Applying the SC-GHGs

Applying the SC-GHG is relatively simple. It is largely a matter of selecting the correct SC-GHG value for the type of GHG and year in which it is emitted, then multiplying that value by the incremental change in emissions. This section offers a sample calculation and includes guidance on related elements such as proper approaches to discounting and sensitivity analysis.

2.1. Recommended discounting approach

This updated SC-GHG guidance is to be used in accordance with the Treasury Board Secretariat's regulatory guidance on CBA, *Canada's Cost-Benefit Analysis Guide for Regulatory Proposals*. Notably, the SC-GHG values presented in Table 1 reflect the use of a lower discount rate than the previous estimates (roughly 2% as opposed to a constant 3% discount rate).

Due to the especially long intergenerational analyses required to comprehensively evaluate climate change impacts on society, a lower discount rate is justified to reflect intertemporal trade-offs more accurately over longer time horizons.

The EPA describes their updated approach to discounting as follows (pg. 2): "This approach uses the Ramsey (1928) discounting formula in which the parameters are calibrated such that (1) the decline in the certainty-equivalent discount rate matches the latest empirical evidence on interest rate uncertainty estimated by Bauer and Rudebusch (2020, 2021) and (2) the average of the certainty-equivalent discount rate over the first decade matches a near-term consumption rate of interest."

To ensure internal consistency in CBA, the same discounting approach should be applied to both streams of future costs and benefits. Accordingly, ECCC recommends that in any CBA or analysis in which SC-GHG values are applied to multiple future years, a 2% discount rate should be used to arrive at a present value of all costs and benefits (see sample calculation below). It is worth noting that costs and benefits outside of those related to GHGs tends to be on shorter time horizons, and so applying a 2% rate is appropriate even with SC-GHG values calculated using a modified Ramsey approach that modifies the rate in the longer-term.

The use of a 2% discount rate is consistent with TBS's regulatory guidance, which elaborates on the Ramsey discounting formula and its use in calculating the Social Discount Rate (see section "6.1 Discount rates," and "Box 2. Calculating the Social Discount Rate").

2.2. Example calculation – application of the SC-GHG in CBA

To demonstrate how the SC-GHG can be applied in benefit-cost analysis, Table 2 below presents an example calculation for a hypothetical regulation. This hypothetical regulation would yield annual reductions in CO_2 emissions as shown in column B.

The first step is to select the proper SC-GHG values. In this case, it is the SCC for years 2021 to 2025, as shown in Column C. For each year within the period of analysis, these SCC estimates are then multiplied by the emission reductions to yield the benefits of this regulation in monetary terms, as shown in Column D.

Column D shows the present value of the change in emissions for the *year in which the emissions occur*. The next step is to apply a discount rate to obtain the present value, or discounted benefits *in the year of analysis*.

The discount factor is obtained with the formula $1/(1+r)^t$, where *t* is the number of years past the year of analysis, and r is a decimal value representing the real discount rate (i.e., 2% would equate to 0.02 in the formula). In the year of analysis, the discount factor is 1, and it decreases in each future year, per the formula.

Finally, to obtain the present value in the year of analysis (i.e., the discounted benefits), the appropriate discount factor (E) is applied to each respective year's societal benefits (D) to determine each year's annual discounted benefits (F). These values are then summed to obtain the Total Climate Benefits (sum of F; presented at bottom of table).

Table 2 – Example SC-GHG calculation for the total climate benefits of a hypothetical regulation (2021 as year of analysis, C$2021, 2% Near-term Ramsey discount rate)

(A) Year	(B) Annual CO_2 Emission Reductions (million tonnes)	(C) SCC Estimate (C$2021)	(D) Annual Societal Benefits (C$ millions) = BxC	(E) Real Discount Rate (2%)	(F) Discounted Benefits (C$ millions) = DxE
2021	5.0	$252	$1,260	1.000	$1,260
2022	7.5	$256	$1,920	0.980	$1,882
2023	10.0	$261	$2,610	0.961	$2,509
2024	12.5	$266	$3,325	0.942	$3,133
2025	15.0	$271	$4,065	0.924	$3,755
Total Climate Benefits (discounted to 2021)	N/A	N/A	N/A	N/A	**$12,539**

The total climate benefits calculated in Table 2 would then be incorporated into the rest of the cost-benefit analysis in accordance with the recommended discounting approach described earlier in this section.

If the year of analysis used in the CBA is anything other than 2021, it is important to update the SCC estimates to account for inflation, as they should be in the same constant dollar terms as the rest of the benefit and cost values. This can be done by applying a conversion factor to all the estimates in Table 1. The conversion factor should be derived from an official GDP deflator or CPI source, such as StatCan, the Bank of Canada, or from other modelling done as part of the regulatory analysis.

2.3. Analyses involving multiple GHGs

For proposed regulations/policies involving multiple types of GHG emissions, the associated SC-GHG estimates for each respective type of GHG should be used for each relevant year. When calculating the total present value, the present value of each stream of GHG emissions should be added together to obtain the total present value of GHG emissions reductions from the proposal. In other words, results from different types of GHGs should be summed to obtain total net GHG benefits.

2.4. Sensitivity analysis

To conduct sensitivity analysis in a CBA, important parameters and/or assumptions used in the analysis are modified to determine the "sensitivity" of the conclusions to the size and nature of these parameters or assumptions. When doing a sensitivity analysis, the SC-GHG estimates may be modified by varying the implicit discount rate. Specifically, the tables of annual estimates presented in Appendix A.1.1. and A.1.2, respectively, provide SC-GHG estimates generated using a lower (1.5%) or higher (2.5%) near-term Ramsey discount rate.

While only a slight deviation in discount rate, because the SC-GHG estimates represent especially long intergenerational impacts, it is appropriate that the deviation in discount rate is bounded by a range that limits the decrease in present value from impacts in distant future periods and remains empirically-reflective of long-run trade-offs in consumption used to inform the near-term rates used in the dynamic discounting approach used by the EPA. Notably, the methodological update of the discounting module used in the updated SC-GHG estimates uses a dynamic discounting approach that directly addresses uncertainties around future growth rates, which have a large impact on the estimated size of future damages, helping to provide a degree of sensitivity analysis incorporated into the derivation of the estimates themselves. In using the one-point range around the main 2% estimates, a range of plausible SC-GHG estimates can be used to explore scenarios assuming different incremental damages from GHG emissions.

2.5. Break-even analysis

When evaluating a proposal with high uncertainty and high costs, as a supplement to CBA, break-even analysis (BEA) is a technique that has been used to estimate the value of a key parameter that would ensure that benefits at least equal costs. In climate change policy, BEA can involve determining the minimum SC-GHG value(s) that will allow a given regulation to break even—i.e., to ensure benefits at least equal costs. Consistent with methodologies used by other jurisdictions, to validate the break-even value, it should fall within a plausible range of established values from recent studies.

ECCC has used BEA in two climate change RIAS, for *Clean Fuel Regulations* published in the *Canada Gazette*, Part II, and the *Regulations Amending the Output-Based Pricing System Regulations and the Environmental Violations Administrative Monetary Penalties Regulations* published in *Canada Gazette*, Part I. Guidance on how to conduct a BEA can be found in the EPA's Guidelines for Preparing Economic Analyses.

With this interim update, BEA remains an option, particularly for regulatory analysis with high degrees of uncertainty regarding cost estimates.

Note that if conducting an associated Monte Carlo analysis, the probability distribution should account for ECCC's preliminary updated SCC estimate (\$247/t-CO_2; per Table 1) and conform to a probability distribution that reflects the uncertainty of this estimate.

Departments considering the use of a break-even analysis of the SCC may contact ECCC's Regulatory Analysis and Valuation Division (RAVD): RAVD.DARV@ec.gc.ca.

3. Estimating the SC-GHG

3.1. Background

In accordance with the ECCC's Technical Guide and the Government's Strengthened Climate Plan commitment to update SC-GHG estimates to reflect the best available science and methodologies, all three SC-GHG estimates have been updated. Relative to the social costs of methane (SCM or SC-CH_4) and nitrous oxide (SCN or SC-N_2O), the social cost of carbon (SCC or SC-CO_2) is the most frequently referenced in academic literature and regulatory analyses.

Since carbon dioxide plays a dominant role in driving global warming and is associated with a broad spectrum of human activities, most of the research on the SC-GHG has focused on the SCC.

To estimate the SC-GHGs, sophisticated models, known as integrated assessment models, have been developed in the academic community that draw on economic and scientific knowledge. These are discussed in Section 3.3 below.

3.2. History

In 2010 and 2011, Environment and Climate Change Canada (ECCC) led an interdepartmental review of approaches to valuing GHG emissions, which recommended the adoption of Social Cost of Carbon (SCC) values based on research and analysis conducted by the U.S. Interagency Working Group on Social Cost of Carbon in 2010. As part of this review, ECCC led an Interdepartmental Working Group from 2010 to 2011.

Initially, an illustrative SCC of $25/t-$CO_2$ was used in Regulatory Impact Analysis Statements (RIAS). It was derived from academic literature and comparable estimates of carbon prices from other jurisdictions, such as the trading value of carbon permits at the time. Following the work of the interdepartmental review in 2011, a schedule of SCC estimates were formally adopted for use in cost-benefit analyses CBAs for all ECCC RIAS involving GHG emissions. Natural Resources Canada and Transport Canada also adopted these values for cost-benefit analyses to support regulatory processes in 2011.

In April 2016, ECCC published its technical update document, which was the first stand-alone document to publicly communicate ECCC's official schedule of SC-GHG values. This update raised the starting value of the SCC to $54/tonne for 2020 emissions from $40/tonne (C$ 2021). In 2018, the Treasury Board of Canada Secretariat (TBS) updated its CBA guidance and included ECCC's SC-GHG as the official monetary values/estimates for GHG emissions to be used in regulatory analyses across all departments and agencies.

Since 2010, extensive international efforts have been undertaken to improve integrated assessment modelling, from the underlying climate science and socioeconomic projections used in forecasting of future emissions to the estimation techniques involved in assessing future climate change impacts and methods used for valuing intergenerational impacts. In particular, following the release of the National Academies of Science, Engineering, and Medicine (NASEM) final report in 2017 on recommendations to improve the estimation of the SC-GHGs, there has been substantial growth in research and institutional collaborations focusing on methodologies underlying the SC-GHG.

The Government of Canada's Strengthened Climate Plan, released in December 2020, committed the federal government to revisiting the SCC/SC-GHG estimates and ensuring Canada's methodology aligns with the best international climate science and economic modelling.

In 2021, the U.S. Interagency Working Group on Social Cost of Greenhouse Gases (U.S. IWG) was established again to update U.S. SC-GHG estimates. The work of the U.S. IWG is ongoing. The U.S. Environmental Protection Agency (EPA), a core member of the U.S. IWG and a centre of expertise on SC-GHG modelling, released a draft of updated SC-GHG guidance for EPA rule-makings on November 11, 2022.

The EPA's draft report incorporated state-of-the-science updates to the SC-GHG, including many of the recommendations of the NASEM and the latest research from academic and institutional collaborations. The draft report is to undergo a 2-month external expert peer-review process alongside a public comment process before being used to help inform EPA's SC-GHG formal SC-GHG guidance update in fall 2023 or winter 2024.

This 2023 interim guidance document is based on the U.S. EPA's draft report and will be revisited after the EPA's peer review and public comment processes have been completed, alongside the EPA's final report on updating SC-GHG guidance.

ECCC has adopted U.S. EPA SC-GHG estimates and converted them to Canadian dollars. Specifically, the U.S. estimates presented in US$ 2020 were first brought to US$ 2021 using the U.S. GDP deflator and then converted to C$2021 using the annual exchange rate for 2021, which closely approximates a conversion using purchasing power parity.

3.3. Integrated Assessment Modelling

Integrated assessment models (IAMs) have played a central role in the estimation of the SC-GHGs. In essence, estimation of the SC-GHG involves integrating knowledge from multiple domains into a climate-economy model to analyze climate change impacts. As outlined in the National Academies of Science, Engineering, and Medicine's report on improving SC-GHG estimation, four separate modules are used to estimate the SC-GHG estimates in an integrated, modular framework. The four modules build upon each other by combining socioeconomic and emissions forecasts, a model of global climate, approaches to assess damages from climate change, and a framework for discounting to put future impacts in present value terms.

The U.S. EPA summarized the process to estimate the SC-GHGs as follows:

> The emissions trajectories from the socioeconomic module are used to project future temperatures in the climate module. The damage module then translates the temperature and other climate endpoints (along with the projections of socioeconomic variables) into physical impacts and associated monetized economic damages, where the damages are calculated as the amount of money the individuals experiencing the climate change impacts would be willing to pay to avoid them. To calculate the marginal effect of emissions, i.e., the SC-GHG in year t, the entire model is run twice – first as a baseline and second with an additional pulse of emissions in year t. After recalculating the temperature effects and damages expected in all years beyond t resulting from the adjusted path of emissions, the losses are discounted to a present value in the discounting module. Much of the uncertainty in the estimation process can be incorporated using Monte Carlo techniques by taking draws from probability distributions that reflect the uncertainty in parameters. (p. 16)

Similar to the U.S. Federal Government, ECCC's previous SC-GHG guidance relied on an set of three widely used IAMs: Dynamic Integrated Climate and Economy (DICE); Climate Framework for Uncertainty, Negotiation, and Distribution (FUND); and Policy Analysis of the Greenhouse Gas Effect (PAGE). In alignment with the EPA's updated SC-GHG guidance, ECCC is now adopting their proposed modular approach to estimating the SC-GHG, consistent with the National Academies' near-term recommendations:

> That is, the methodology underlying each component, or module, of the SC-GHG estimation process draws on expertise from the scientific disciplines relevant to that component. Under this approach, each step in the SC-GHG estimation improves consistency with the current state of scientific knowledge, enhances transparency, and allows for more explicit representation of uncertainty. (p. 17)

For a detailed discussion of the methodological updates adopted by ECCC, please see the Draft Report on the Social Cost of Greenhouse Gases prepared by the U.S. EPA.

4. Frequently Asked Questions

4.1. Is the carbon price equal to the social cost of carbon?

No. Carbon pollution pricing and the social cost of carbon (SCC) are distinct. The SCC is an estimate of the *global* damages associated with one tonne of carbon emitted – it is a metric and not a policy. In contrast, a carbon price is a *domestic* GHG mitigation policy that incents people and businesses to reduce emissions. Carbon pricing is a key pillar of the Government of Canada's climate action plan, but given other policies and regulations proposed or in place, it is not intended to be the single instrument to reduce GHG emissions. A range of considerations, including Canada's GHG reduction goals, informs setting the benchmark carbon pollution price.

4.2. Can I use global warming potentials (GWP) to convert between different SC-GHG estimates?

This is not recommended. The appropriate SC-GHG estimates should be used for each type of GHG for which social costs have been established.

The issues with using GWP in combination with the SCC instead of the appropriate SC-GHG estimates to approximate values for non-CO_2 GHGs have been summarized in the previous Technical Guidance, which cited the U.S. EPA's Regulatory Impact Analysis for the *Proposed Emissions Standards for New and Modified Sources in the Oil and Natural Gas Sector* (see RLSO, 8-14-2015):

The GWP is not ideally suited for use in benefit-cost analyses to approximate the social cost of non-CO_2 GHGs because it ignores important nonlinear relationships beyond radiative forcing in the chain between emissions and damages. These can become relevant because gases have different lifetimes and the SC-CO_2 takes into account the fact that marginal damages from an increase in temperature are a function of existing temperature levels. Another limitation of gas comparison metrics for this purpose is that some environmental and socioeconomic impacts are not linked to all of the gases under consideration, or radiative forcing for that matter, and will therefore be incorrectly allocated. For example, the economic impacts associated with increased agricultural productivity due to higher atmospheric CO_2 concentrations included in the SC-CO_2 would be incorrectly allocated to methane emissions with the GWP-based valuation approach.

Also of concern is the fact that the assumptions made in estimating the GWP are not consistent with the assumptions underlying SC-CO_2 estimates in general, and the SC-CO_2 estimates developed by the IWG more specifically. For example, the 100-year time horizon usually used in estimating the GWP is less than the approximately 300-year horizon the IWG used in developing the SC-CO_2 estimates. The GWP approach also treats all impacts within the time horizon equally, independent of the time at which they occur. This is inconsistent with the role of discounting in economic analysis, which accounts for a basic preference for earlier over later gains in utility and expectations regarding future levels of economic growth. In the case of methane, which has a relatively short lifetime compared to CO_2, the temporal independence of the GWP could lead the GWP approach to underestimate the SC-CH_4 with a larger downward bias under higher discount rates (Marten and Newbold, 2012).

The exception is when working with a GHG for which no social cost estimates have yet been calculated. In such cases, using GWP to convert from SCC values may be a reasonable proxy.

5. Future work

This document will be updated as needed to incorporate future developments in scientific and economic research as the state of the science progresses on SC-GHG estimation.

All sources of literature on the SC-GHG have emphasized the importance of maintaining "evergreen" estimates: from government reports, such as ECCC's original Technical Guidance, the NASEM recommendations on improving SC-GHG estimation, and the U.S. Executive Order initiating the U.S. Federal Government SC-GHG update in 2021 to the growing body of academic literature (e.g., The social cost of carbon with intragenerational inequality and economic uncertainty, The mortality cost of carbon, and Economic impacts of tipping points in the climate system). Further, ongoing institutional collaborations (e.g., think tanks such as Resources for the Future and Climate Impact Lab) that are working to develop methodological improvements in the underlying science and economic modelling behind SC-GHG estimates hold promise for important future revisions to better capture the scope of climate science, impacts, and damages included in SC-GHG estimates.

Future updates could result from improvements in integrated assessment modelling approaches underlying each module (i.e., socioeconomic, climate, damages, and discounting) or the addition of additional GHGs (e.g., SC-HFCs, or social cost of hydrofluorocarbons). In this manner, the estimates may strive to reflect the state-of-the-science on our understanding of the impacts of incremental/marginal GHG emissions on society.

ECCC will continue to lead the processes to update the estimates and will reconvene the Canadian Interdepartmental Working Group as needed to ensure implicated departments and agencies are fully aware of any impending changes.

Appendix A.1 – Additional tables of annual SC-GHG estimates (SC-CO_2, SC-CH_4, and SC-N_2O)

For use in sensitivity analysis, Tables A.1.1 and A.1.2 contain annual values for the three SC-GHGs at the other two discount rates (1.5% and 2.5%, respectively) provided by the U.S. EPA after converting to constant 2021 Canadian dollars in the same manner as demonstrated in Table 1.

Annual SC-CO_2, SC-CH_4, and SC-N_2O values, 2020-2080, C$2021, 1.5% Near-term Ramsey discount rate

Table A.1.1: Updated SC-GHG estimates (C$2021, $/tonne of respective GHG)

Year	SCC/SC-CO_2	SCM/SC-CH_4	SCN/SC-N_2O
2020	$431	$2,948	$111,614

Year	SCC/SC-CO_2	SCM/SC-CH_4	SCN/SC-N_2O
2021	$436	$3,057	$113,641
2022	$442	$3,169	$115,668
2023	$449	$3,279	$117,696
2024	$455	$3,389	$119,723
2025	$460	$3,500	$121,750
2026	$467	$3,610	$123,778
2027	$473	$3,721	$125,805
2028	$480	$3,831	$127,832
2029	$486	$3,942	$129,860
2030	$491	$4,052	$131,886
2031	$497	$4,182	$133,920
2032	$504	$4,311	$135,952
2033	$509	$4,439	$137,985
2034	$515	$4,568	$140,017
2035	$522	$4,697	$142,050
2036	$527	$4,826	$144,082
2037	$533	$4,955	$146,115
2038	$540	$5,083	$148,147
2039	$545	$5,212	$150,180
2040	$551	$5,341	$152,212

Year	SCC/SC-CO_2	SCM/SC-CH_4	SCN/SC-N_2O
2041	$558	$5,479	$154,485
2042	$564	$5,619	$156,757
2043	$570	$5,757	$159,028
2044	$577	$5,895	$161,300
2045	$583	$6,033	$163,573
2046	$591	$6,173	$165,845
2047	$597	$6,311	$168,116
2048	$604	$6,449	$170,388
2049	$610	$6,587	$172,661
2050	$616	$6,726	$174,932
2051	$623	$6,858	$177,080
2052	$628	$6,990	$179,227
2053	$634	$7,121	$181,375
2054	$639	$7,253	$183,522
2055	$646	$7,384	$185,669
2056	$652	$7,515	$187,818
2057	$657	$7,647	$189,965
2058	$664	$7,779	$192,113
2059	$669	$7,910	$194,260
2060	$675	$8,042	$196,408

Year	SCC/SC-CO_2	SCM/SC-CH_4	SCN/SC-N_2O
2061	$680	$8,165	$198,315
2062	$684	$8,286	$200,222
2063	$689	$8,409	$202,127
2064	$694	$8,531	$204,034
2065	$699	$8,653	$205,940
2066	$703	$8,775	$207,847
2067	$708	$8,898	$209,753
2068	$714	$9,019	$211,660
2069	$719	$9,142	$213,567
2070	$722	$9,263	$215,473
2071	$728	$9,391	$217,404
2072	$733	$9,519	$219,335
2073	$737	$9,648	$221,266
2074	$742	$9,776	$223,197
2075	$746	$9,904	$225,128
2076	$751	$10,032	$227,059
2077	$756	$10,161	$228,990
2078	$760	$10,289	$230,919
2079	$765	$10,417	$232,850
2080	$769	$10,545	$234,781

Annual SC-CO_2, SC-CH_4, and SC-N_2O values, 2020-2080, C$2021, 2.5% Near-term Ramsey discount rate

Table A.1.2: Updated SC-GHG estimates (C$2021, $/tonne of respective GHG)

Year	SCC/SC-CO_2	SCM/SC-CH_4	SCN/SC-N_2O
2020	$150	$1,607	$45,053
2021	$152	$1,693	$46,265
2022	$156	$1,777	$47,477
2023	$160	$1,863	$48,690
2024	$164	$1,949	$49,902
2025	$166	$2,033	$51,114
2026	$170	$2,119	$52,326
2027	$174	$2,205	$53,539
2028	$178	$2,290	$54,751
2029	$180	$2,375	$55,963
2030	$184	$2,460	$57,175
2031	$188	$2,560	$58,430
2032	$192	$2,660	$59,684
2033	$196	$2,758	$60,939
2034	$198	$2,858	$62,193
2035	$202	$2,958	$63,448
2036	$206	$3,057	$64,702

Year	SCC/SC-CO_2	SCM/SC-CH_4	SCN/SC-N_2O
2037	$210	$3,156	$65,955
2038	$214	$3,256	$67,210
2039	$217	$3,355	$68,464
2040	$221	$3,455	$69,719
2041	$225	$3,563	$71,139
2042	$229	$3,671	$72,561
2043	$233	$3,779	$73,982
2044	$238	$3,887	$75,403
2045	$242	$3,995	$76,825
2046	$246	$4,104	$78,245
2047	$249	$4,211	$79,667
2048	$254	$4,320	$81,088
2049	$258	$4,427	$82,509
2050	$262	$4,536	$83,931
2051	$266	$4,634	$85,258
2052	$270	$4,733	$86,587
2053	$274	$4,832	$87,914
2054	$277	$4,931	$89,243
2055	$281	$5,029	$90,570
2056	$284	$5,129	$91,899

Year	SCC/SC-CO_2	SCM/SC-CH_4	SCN/SC-N_2O
2057	$288	$5,228	$93,226
2058	$292	$5,326	$94,555
2059	$295	$5,426	$95,882
2060	$299	$5,524	$97,211
2061	$302	$5,612	$98,361
2062	$306	$5,701	$99,512
2063	$308	$5,789	$100,663
2064	$312	$5,877	$101,814
2065	$315	$5,967	$102,965
2066	$317	$6,055	$104,115
2067	$321	$6,143	$105,265
2068	$324	$6,231	$106,416
2069	$327	$6,320	$107,567
2070	$330	$6,408	$108,718
2071	$334	$6,502	$109,988
2072	$336	$6,598	$111,259
2073	$340	$6,693	$112,529
2074	$344	$6,789	$113,799
2075	$347	$6,884	$115,068
2076	$350	$6,979	$116,338

Year	SCC/SC-CO_2	SCM/SC-CH_4	SCN/SC-N_2O
2077	$353	$7,074	$117,608
2078	$357	$7,170	$118,878
2079	$361	$7,265	$120,149
2080	$363	$7,360	$121,419

Date modified:

2023-04-20