

# Social Costs of Greenhouse Gases

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## Climate change imposes significant costs on society.

**S**cientific studies show that climate change will have, and in some cases has already had, severe consequences for society, like the spread of disease, increased food insecurity, and coastal destruction. These damages from emitting greenhouse gases are not reflected in the price of fossil fuels, creating what economists call “externalities.” **The social cost of carbon (SCC) is a metric designed to quantify climate damages, representing the net economic cost of carbon dioxide emissions.** The SCC can be used to evaluate policies that affect greenhouse gas emissions. Simply, the SCC is a monetary estimate of the damage done by each ton of carbon dioxide<sup>1</sup> that is released into the air.

In order to maximize social welfare, policymakers must ensure that the market properly accounts for all externalities, like greenhouse gas pollution. By failing to account fully for carbon pollution, for example, policymakers would tip the scales in favor of dirtier energy sources, letting polluters pass the costs of their carbon emissions onto the public. **Incorporating the SCC into policy analysis removes that bias by accounting for the costs of such pollution.**

## The Social Cost of Carbon is a critical tool, offering information to help assess policies.

**The SCC allows federal agencies to weigh the benefits of mitigating climate change against the costs of limiting carbon pollution** when they conduct regulatory analyses of federal actions that affect carbon emissions. To date, the SCC has been used to evaluate approximately 100 federal actions.

**Any effort to limit the use of the SCC, or alter its value so it no longer reflects the best available science, would be detrimental to the public interest. Such efforts would threaten an important policy tool and conceal the economic impacts of climate change.**

## **A federal court ruling spurred the development of the official U.S. SCC.**

A ruling by the U.S. Court of Appeals for the Ninth Circuit in 2008 required the federal government to account for the economic effects of climate change in a regulatory impact analysis of fuel efficiency standards.<sup>2</sup> As a result, President Obama convened an Interagency Working Group (IWG) in 2009 to develop an SCC value for use in federal regulatory analysis. The SCC is now used in agencies' regulatory cost-benefit analyses and environmental impact statements of federal actions that affect greenhouse gas emissions. More recently, a 2016 ruling by the U.S. Court of Appeals for the Seventh Circuit upheld the Department of Energy's use of the SCC in its analysis of a rule on energy efficiency standards for commercial refrigerators.<sup>3</sup>

## **The SCC was developed through an academically rigorous, regularly updated and peer-reviewed process.**

The IWG developed the SCC values using the three most widely cited climate economic impact models that link physical impacts to the economic damages of CO<sub>2</sub> emissions. All of these integrated assessment models—known as DICE, FUND, and PAGE<sup>4</sup>—have been extensively peer reviewed in the economic literature.<sup>5</sup> Each model translates emissions into changes in atmospheric carbon concentrations, atmospheric concentrations into temperature changes, and temperature changes into economic damages.<sup>6</sup> The IWG gives each model equal weight in developing the SCC values.<sup>7</sup>

The IWG used a robust, rigorous process, incorporating peer review of the estimates underlying the models and other inputs. Since its inception, **the IWG has met several times to update its modeling to incorporate new scientific literature, and has sought input from experts to ensure that the SCC is based on the latest science.** The most recent update by the IWG in 2016 reflects recommendations on the SCC from the National Academy of Sciences, and expands the group's analysis to include two additional potent greenhouse gases: methane and nitrous oxide.<sup>8</sup>

**The National Academy of Sciences completed a robust review of the SCC calculation in 2017, lending additional credibility to the metric and endorsing several changes that would likely lead to a higher SCC estimate.**<sup>9</sup> The National Academy of Sciences' full recommendations lay out future steps for the IWG to ensure that the SCC reflects the best available science and economics. The recommendations support the use of both declining discount rates (which would likely increase the SCC value) and a global damage calculation (more on both topics below). **Because the federal SCC estimates have been based on rigorous and peer-reviewed science and economics, these values are a good basis for thoughtful policy analysis.**

## The SCC is the most accurate existing estimate of the external cost of carbon dioxide emissions.

**The central SCC estimate of around \$41 per ton of CO<sub>2</sub> (in 2016 dollars) is the best available estimate.** Of course, there is uncertainty over the science and economics of climate change. This uncertainty is due to the complexity of the climate system, the difficulty of placing a monetary value on environmental services, the long time horizon over which climate change occurs, and the unprecedented amount of carbon emissions that have entered the atmosphere since the industrial revolution. As science and economics improve and progress, this uncertainty will decline, but **uncertainty can never be fully eliminated from future predictions. The fact that there is uncertainty about the exact impacts of climate change does not mean that there is no social cost of carbon dioxide emissions.** In fact, according to the models that calculate the SCC, uncertainty implies a higher SCC value and a need for more stringent climate policies.<sup>10</sup>

**The SCC increases over time** to reflect how the effects of climate change will intensify as more greenhouse gases accumulate in the atmosphere. The IWG's central estimate for 2050 will be almost \$70.<sup>11</sup>

## Several categories of climate damages are omitted from the SCC.

While the 2016 IWG estimate is the best available SCC figure, it **likely represents a lower bound for the costs of climate change** because the models omit several categories of damage. Many omissions result from a lack of readily available monetary damage estimates for certain climate impacts. Damages currently omitted from the models include the effects of climate change on fisheries; the effects of increased pest, disease, and fire pressures on agriculture and forests; and the effects of climate-induced migration. Additionally, these models omit the effects of climate change on economic growth and the rise in the future value of environmental services due to increased scarcity.<sup>12</sup>

## U.S. states and corporations also use a value for the cost of carbon in their decisionmaking and planning.<sup>13</sup>

Increasingly, **U.S. states are using the federal SCC.** California, Illinois, Minnesota, Maine, New York, and Washington have begun using the federal SCC in energy-related decisionmaking.<sup>14</sup> Different states make different choices for what SCC estimates to use: Minnesota uses a range of SCC values; New York uses the “central” estimate (with a 3% discount rate); and Washington uses a higher estimate (based on a 2.5% discount rate). The importance of choosing the right SCC value is explored below.

Many major companies also quantify the cost of carbon pollution in their financial planning. According to a 2013 Carbon Disclosure Project (CDP) report, 29 prominent companies based in or doing business in the United States reported that they use an internal price on carbon pollution in their financial planning, to help weigh risks and opportunities related to climate change.<sup>15</sup>

## Decisionmakers can choose from multiple SCC values.

**The federal SCC estimates are not a single number, but instead a range of four estimates,** based on three discount

rates, plus a 95th percentile estimate that represents catastrophic, low-probability outcomes.<sup>16</sup> Discount rates allow economists to measure the value of money over time—the tradeoff between what a dollar is worth today and what a dollar would be worth in the future.<sup>17</sup> Higher discount rates result in a lower SCC; if future climate damages are discounted at a high rate, we would be placing less value on avoiding those damages today. The IWG uses discount rates of 5, 3, and 2.5 percent.<sup>18</sup> The fourth value is taken from the 95th percentile of the SCC in all models with the 3-percent discount rate, which represents catastrophic but unlikely situations.<sup>19</sup> Frequently, agencies will conduct their economic analyses using a range of SCC values.<sup>20</sup> Other analyses will focus on a “central” estimate of the SCC.<sup>21</sup> The SCC estimate using the 3-percent discount rate is considered to be the “central” estimate.<sup>22</sup>

**Choosing the most appropriate discount rate is crucial to obtaining the best SCC estimate.** A policymaker might decide that the uncertainty associated with climate damages warrants using a discount rate that declines over time, leading to a higher SCC.<sup>23</sup> A consensus has emerged among leading climate economists that a declining discount rate should be used for climate damages, to reflect long-term uncertainty in interest rates. The National Academy of Sciences January 2017 recommendations to the IWG support this approach.<sup>24</sup> Furthermore, because several types of damage from climate change are missing or poorly quantified in the SCC estimates, **the federal SCC estimate associated with a 3-percent discount rate should be interpreted as a lower bound on the central estimate.**<sup>25</sup>

Finally, the global nature of climate change affects the scope of damages that go into the SCC calculations. Some commentators have argued that the SCC should include only domestic damages.<sup>26</sup> However, the IWG and many others have concluded that the SCC should reflect global climate damages, citing numerous reasons including the trans-border nature of most damages and the need to encourage international coordination to address climate change.<sup>27</sup> As the National Academy of Sciences and others have shown, disaggregating domestic damages from the models is exceedingly complex, and current approaches tend to ignore the interconnectedness of the global economy.<sup>28</sup> **Using a domestic-only SCC would underestimate the true extent of climate damages.**

## The SCC includes benefits from climate change.

Some have argued against using the SCC because climate change might have some beneficial effects, which they imply are being ignored in the SCC. But many categories of benefits that might result from climate change, such as potential increases in agricultural yields, are already captured in the SCC estimate. Other benefits are omitted, such as the increased availability of oil due to higher temperatures in the Arctic and the potential for fewer transportation delays from snow and ice. However, **omitted negative impacts almost certainly counteract any omitted benefits.**<sup>29</sup> Other benefits from the use of fossil fuels that are unrelated to climate change (e.g., economic output) are omitted from the SCC estimates, but are included in any cost-benefit analysis in which the SCC is used. In such an analysis, the cost of a regulation, such as the potential loss of output, is always balanced against the benefits of carbon emissions reductions.

## There are social cost estimates for other greenhouse gases.

**The IWG has also developed robust federal estimates of the social cost of methane (SC-CH<sub>4</sub>) and social cost of nitrous oxide (SC-N<sub>2</sub>O).** The SC-CH<sub>4</sub> and SC-N<sub>2</sub>O methodologies build directly on the IWG’s SCC methodology, and replace the less accurate methodology of multiplying the SCC by these gases’ relative global warming potential. Therefore, the same rigorous, consensus-based, transparent process used for the federal SCC has shaped the federal SC-CH<sub>4</sub> and federal SC-N<sub>2</sub>O estimates. Just as the federal SCC likely underestimates the true social cost of carbon, the

federal SC-CH<sub>4</sub> and SC-N<sub>2</sub>O are **likely to underestimate the true social cost of these other greenhouse gases** due to omitted damages and uncertainties regarding the scope of the effects in the underlying models.<sup>30</sup> Nonetheless, the 2016 IWG SC-CH<sub>4</sub> and SC-N<sub>2</sub>O are the best available estimates of the social costs associated with the emission of those greenhouse gases.

## Endnotes

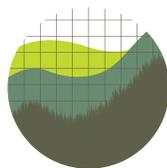
- <sup>1</sup> There are many ways to measure a ton (2000 pounds) of carbon dioxide. Simply, a ton of carbon dioxide is the amount of carbon dioxide that the average U.S. car emits in 2 to 2.5 months. An important distinction is that, because carbon dioxide consists of carbon and oxygen, 3.67 tons of carbon dioxide is equivalent to 1 ton of carbon.
- <sup>2</sup> *Ctr. for Biological Diversity v. Nat'l Highway Traffic and Safety Admin.*, 538 F.3d 1172 (9th Cir. 2008).
- <sup>3</sup> *Zero Zone, Inc. v. U.S. Dep't of Energy*, Case No. 14-2147 (7th Cir. Aug. 8, 2016).
- <sup>4</sup> More specifically: DICE (Dynamic Integrated Climate and Economy), developed by William Nordhaus (more information available at <http://www.econ.yale.edu/~nordhaus/>); PAGE (Policy Analysis of the Greenhouse Effect), developed by Chris Hope; and FUND (Climate Framework for Uncertainty, Negotiation, and Distribution), developed by Richard Tol (more information available at <http://www.fund-model.org/>). See INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, UNITED STATES GOVERNMENT, TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866, at II-3 (2010) 14A-5 n.b. [hereinafter 2010 TSD].
- <sup>5</sup> See *id.* at 14A-4.
- <sup>6</sup> *Id.* at 14A-6.
- <sup>7</sup> *Id.* at 14A-5.
- <sup>8</sup> INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, UNITED STATES GOVERNMENT, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 (2016) [hereinafter 2016 TSD].
- <sup>9</sup> See Chelsea Harvey, *Scientists have a new way to calculate what global warming costs. Trump's team isn't going to like It*, THE WASHINGTON POST (Jan. 2017), available at <https://www.washingtonpost.com/news/energy-environment/wp/2017/01/12/scientists-have-a-new-way-to-calculate-what-global-warming-costs-trumps-team-isnt-going-to-like-it>.
- <sup>10</sup> William D. Nordhaus, *Revisiting the Social Cost of Carbon*, 514 PROC. NATL. ACAD. SCI. U.S.A. 7 (2017).
- <sup>11</sup> EPA, THE SOCIAL COST OF CARBON: ESTIMATING THE BENEFITS OF REDUCING GREENHOUSE GAS EMISSIONS, available at <https://perma.cc/94LF-5M7D>.
- <sup>12</sup> Peter Howard, COST OF CARBON PROJECT, OMITTED DAMAGES: WHAT'S MISSING FROM THE SOCIAL COST OF CARBON (2014), available at [http://costofcarbon.org/files/Omitted\\_Damages\\_Whats\\_Missing\\_From\\_the\\_Social\\_Cost\\_of\\_Carbon.pdf](http://costofcarbon.org/files/Omitted_Damages_Whats_Missing_From_the_Social_Cost_of_Carbon.pdf) [hereinafter OMITTED DAMAGES].
- <sup>13</sup> Many other nations also use the SCC or similar concepts in making regulatory decisions, including France, Germany, Norway, and the United Kingdom. Canada and Mexico have harmonized their SCC estimates with the U.S. federal estimates, while many other countries estimate their own SCC; Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations, SOR/2012-167, 146 Can. Gazette pt. II, 1951, 2000, 2044 (Can.), available at <http://www.gazette.gc.ca/rp-pr/p2/2012/2012-09-12/html/sor-dors167-eng.html>.
- <sup>14</sup> See Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, New York Public Service Commission Case No. 14-M-0101, Institute for Policy Integrity Comments on Staff White Paper on Benefit-Cost

Analysis in the Reforming Energy Vision Proceeding, Filing No. 447, at 22 (Aug. 21, 2015).

- <sup>15</sup> These companies include Microsoft, General Electric, Walt Disney, ConAgra Foods, Wells Fargo, DuPont, Duke Energy, Google, Delta Air Lines, Walmart, and PG&E. The Exxon Mobil Corporation uses \$80 for a metric ton of CO<sub>2</sub> emissions in 2040 (<http://www.eenews.net/climatewire/2016/12/16/stories/1060047318>); this exceeds the central U.S. SCC estimate for 2040.
- <sup>16</sup> 2010 TSD *supra* note 4; INTERAGENCY WORKING GROUP ON THE SOCIAL COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 (2013); Interagency Working Group on the Social Cost of Carbon, Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866 (2015); 2016 TSD *supra* note 8.
- <sup>17</sup> If offered \$1 now or \$1 in a year, almost everyone would choose to receive the \$1 now. Most individuals would only wait until next year if they were offered more money in the future. The discount rate is how much more you would have to receive to wait until next year.
- <sup>18</sup> The IWG correctly excluded a 7% discount rate, a standard private sector rate of return on capital, in its SCC calculations for two main reasons. First, typical financial decisions, such as how much to save in a bank account, focus on private decisions and use private rates of return. However, in the context of climate change, analysts are concerned with social discount rates because emissions mitigation is a public good, where individual emissions choices affect public well-being broadly. Second, climate change is expected to primarily affect consumption, not traditional capital investments.
- <sup>19</sup> See Environmental Defense Fund, Institute for Policy Integrity at New York University School of Law, Natural Resources Defense Council, and Union of Concerned Scientists. Comments on Proposed Exception to the Colorado Roadless Rule (RIN 0596-AD26) and Supplemental Draft Environmental Impact Statement (November 2015) to Forest Service; Council on Environmental Quality; Office of Information and Regulatory Affairs to describe importance of 95th percentile value.
- <sup>20</sup> See, e.g., Energy Conservation Program: Energy Conservation Standards for Miscellaneous Refrigeration Products, 81 Fed. Reg. 75,194 (Oct. 26, 2016); Cross-State Air Pollution Rule Update for the 2008 Ozone NAAQS, 81 Fed. Reg. 74,504 (Oct. 26, 2016).
- <sup>21</sup> See, e.g., Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, Order Establishing the Benefit Cost Analysis Framework, New York Public Service Comm'n Case No. 14-M-0101 (Jan. 21, 2016).
- <sup>22</sup> According to the 2010 TSD, the 3% discount rate estimate is considered the central estimate because it uses the central (i.e., middle) discount rate and is based on an average, rather than worse-than-expected, climate outcome; the average climate outcome is the standard assumption made by the IWG 2010 TSD, *supra* 4 note.
- <sup>23</sup> See Martin L. Weitzman, *Gamma Discounting*, 91 AM. ECON. REV. 260, 270 (2001); Kenneth J. Arrow et al., *Determining Benefits and Costs for Future Generations*, 341 SCIENCE 349 (2013); Kenneth J. Arrow et al., *Should Governments Use a Declining Discount Rate in Project Analysis?*, 8 REV ENVTL. ECON. & POLICY 1 (2014); Maureen L. Cropper et al., *Declining Discount Rates*, 104 AM. ECON. REV. 538 (2014); Christian Gollier & Martin L. Weitzman, *How Should the Distant Future Be Discounted When Discount Rates Are Uncertain?* 107 ECONOMICS LETTERS 3 (2010). Policy Integrity further explores the use of declining discount rates in its recent comments to the National Academies of Sciences. See Institute for Policy Integrity at NYU School of Law. Recommendations for Changes to the Final Phase 1 Report on the Social Cost of Carbon; Recommendations in Anticipation of the Phase 2 Report on the Social Cost of Carbon to the National Academies of Sciences (April 29, 2016).
- <sup>24</sup> NATIONAL ACADEMIES OF SCIENCES, ENGINEERING AND MEDICINE, *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide*, National Academies Press (January 2017) [hereinafter *Valuing Climate Damages*].
- <sup>25</sup> See OMITTED DAMAGES, *supra* note 12; Richard L. Revesz et al., *Global Warming: Improve Economic Models of Climate Change*, 508 NATURE 173 (2014) (co-authored with Nobel laureate Kenneth Arrow).
- <sup>26</sup> Ted Gayer & W. Kip Viscusi, *Determining the Proper Scope of Climate Change Benefits* (Vanderbilt Law and Economics Working Paper 14-20, 2015).
- <sup>27</sup> E.g., Peter Howard and Jason Schwartz, *Think Global: International Reciprocity as Justification for a Global Social Cost of Carbon* (Institute for Policy Integrity at NYU School of Law Working Paper, 2016).
- <sup>28</sup> *Valuing Climate Damages*, *supra* note 24 at 12-13.

<sup>29</sup> See OMITTED DAMAGES, *supra* note 11.

<sup>30</sup> Marten, A.L., E.A. Kopits, C.W. Griffiths, S.C. Newbold and A. Wolverton, *Incremental CH<sub>4</sub> and N<sub>2</sub>O Mitigation Benefits Consistent with the U.S. Government's SCC Estimates*, CLIMATE POLICY (2014), DOI: 10.1080/14693062.2014.912981; Environmental Defense Fund, Institute for Policy Integrity at New York University School of Law, Natural Resources Defense Council, and Union of Concerned Scientists Comments on EERE-2015-BT-STD-0016, Energy Conservation Standards for WICF Refrigeration System and EERE-2014-BT-STD-0031, Energy Conservation Standards for Residential Furnaces (November 7, 2016).



Institute for  
**Policy Integrity**  
NEW YORK UNIVERSITY SCHOOL OF LAW

For more information contact Derek Sylvan – [derek.sylvan@nyu.edu](mailto:derek.sylvan@nyu.edu)

Institute for Policy Integrity  
New York University School of Law  
Wilf Hall, 139 MacDougal Street, New York, New York 10012  
[policyintegrity.org](http://policyintegrity.org)