Fact Sheet: Social Cost of Carbon

Background

EPA and other federal agencies use the social cost of carbon (SCC) to estimate the climate benefits of rulemakings. The SCC is an estimate of the economic damages associated with a small increase in carbon dioxide (CO_2) emissions, conventionally one metric ton, in a given year. This dollar figure also represents the value of damages avoided for a small emission reduction (i.e. the benefit of a CO_2 reduction).

The SCC is meant to be a comprehensive estimate of climate change damages and includes, among other things, changes in net agricultural productivity, human health, and property damages from increased flood risk. However, it does not currently include all important damages. As noted by the IPCC Fourth Assessment Report, it is "very likely that [the SCC] underestimates" the damages. The models used to develop SCC estimates do not currently include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature because of a lack of precise information on the nature of damages and because the science incorporated into these models naturally lags behind the most recent research. Nonetheless, the SCC is a useful measure to assess the benefits of CO_2 reductions.

The timing of the emission release (or reduction) is key to estimation of the SCC, which is based on a present value calculation. The integrated assessment models first estimate damages occurring after the emission release and into the future, often as far out as the year 2300. The models then discount the value of those damages over the entire time span back to present value to arrive at the SCC. For example, the SCC for the year 2020 represents the present value of climate change damages that occur between the years 2020 and 2300 (assuming 2300 is the final year of the model run); these damages are associated with the release of one ton of carbon dioxide in the year 2020. The SCC will vary based on the year of emissions for multiple reasons. In model runs where the last year is fixed (e.g., 2300), the time span covered in the present value calculation will be smaller for later emission years—the SCC in 2050 will include 40 fewer years of damages than the 2010 SCC estimates. This modeling choice—selection of a fixed end year—will place downward pressure on the SCC estimates for later emission years. Alternatively, the SCC should increase over time because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed in response to greater levels of climatic change.

One of the most important factors influencing SCC estimates is the discount rate. A large portion of climate change damages are expected to occur many decades into the future and the present value of those damages (the value at present of damages that occur in the future) is highly dependent on the discount rate. To understand the effect that the discount rate has on present value calculations, consider the following example. Let's say that you have been promised that in 50 years you will receive $1 billion. In "present value" terms, that sum of money is worth $291 million today with a 2.5 percent discount rate. In other words, if you invested $291 million today at 2.5 percent and let it compound, it would be worth $1 billion in 50 years. A higher

discount rate of 3 percent would decrease the value today to $228 million, and the value would be even lower—$87 million-- with a 5 percent rate. This effect is even more pronounced when looking at the present value of damages further out in time. The value of $1 billion in 100 years is $85 million, $52 million, and $8 million, for discount rates of 2.5 percent, 3 percent, and 5 percent, respectively. Similarly, the selection of a 2.5 percent discount rate would result in higher SCC estimates than would the selection of 3 and 5 percent rates, all else equal.

Process Used to Develop the SCC

An interagency working group was convened by the Council of Economic Advisers and the Office of Management and Budget in 2009-2010 to design an SCC modeling exercise and develop estimates for use in rulemakings. The interagency group was comprised of scientific and economic experts from the White House and federal agencies, including: Council on Environmental Quality, National Economic Council, Office of Energy and Climate Change, and Office of Science and Technology Policy, EPA, and the Departments of Agriculture, Commerce, Energy, Transportation, and Treasury. The interagency group identified a variety of assumptions, which EPA then used to estimate the SCC using three integrated assessment models, which each combine climate processes, economic growth, and interactions between the two in a single modeling framework.

SCC Values

The 2009-2010 interagency group developed a set of four SCC estimates for use in regulatory analyses. The first three values are based on the average SCC from three integrated assessment models, at discount rates of 5, 3, and 2.5 percent. SCC estimates based on several discount rates are included because the literature shows that the SCC is highly sensitive to the discount rate and because no consensus exists on the appropriate rate to use for analyses spanning multiple generations. The fourth value is the 95th percentile of the SCC from all three models at a 3 percent discount rate, and is intended to represent the potential for higher-than-average damages. See the SCC Technical Support Document (PDF, 51pp, 848K) for a complete discussion about the methodology and resulting estimates.

The interagency group recently updated these estimates, using new versions of each integrated assessment model and published them in May 2013. The 2013 interagency process did not revisit the 2009-2010 interagency modeling decisions (e.g., with regard to the discount rate, reference case socioeconomic and emission scenarios or equilibrium climate sensitivity). Rather, improvements in the way damages are modeled are confined to those that have been incorporated into the latest versions of the models by the developers themselves and as used in the peer-reviewed literature.

The SCC estimates using the updated versions of the models are higher than those developed in the 2009-2010 modeling exercise. The four 2020 SCC estimates reported in the 2010 interagency group were $7, $28, $44 and $86 per metric ton (2011$). The corresponding four updated SCC estimates for 2020 are $13, $46, $68, and $137 per metric ton (2011$). The May 2013 SCC Technical Support Document (PDF, 22pp, 780K) provides a detailed discussion of the model updates relevant to these estimates.

The table below summarizes the four SCC estimates in certain years.

Social Cost of CO_2, 2015-2050 [a] (in 2011 Dollars)

Year	Discount Rate and Statistic			
	5% Average	3% Average	2.5% Average	3% 95th percentile
2015	$12	$39	$61	$116
2020	$13	$46	$68	$137
2025	$15	$50	$74	$153
2030	$17	$55	$80	$170
2035	$20	$60	$85	$187
2040	$22	$65	$92	$204
2045	$26	$70	$98	$220
2050	$28	$76	$104	$235

[a] The SCC values are dollar-year and emissions-year specific.

Examples of SCC Applications to Rulemakings

EPA has used the SCC to analyze the carbon dioxide impacts of various rulemakings since the interagency group first published estimates in 2010. Examples of these rulemakings include:

- The Joint EPA/Department of Transportation Rulemaking to establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards (2012-2016)
- Amendments to the National Emission Standards for Hazardous Air Pollutants and New Source Performance Standards (NSPS) for the Portland Cement Manufacturing Industry
- Regulatory Impact Results for the Reconsideration Proposal for National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers and Process Heaters at Major Sources
- Proposed National Emission Standards for Hazardous Air Pollutants (NESHAP) for Mercury Emissions from Mercury Cell Chlor Alkali Plants
- Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Commercial and Industrial Solid Waste Incineration Units Standards
- Final Mercury and Air Toxics Standards
- Joint EPA/Department of Transportation Rulemaking to establish Medium- and Heavy - Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards
- Proposed Carbon Pollution Standard for Future Power Plants
- Joint EPA/Department of Transportation Rulemaking to establish 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards

Limitations of SCC

The interagency group noted a number of limitations to the SCC analysis, including the incomplete way in which the integrated assessment models capture catastrophic and non-catastrophic impacts, their incomplete treatment of adaptation and technological change, uncertainty in the extrapolation of damages to high temperatures, and assumptions regarding risk aversion. Additional details are discussed in the 2010[1] and 2013[2] SCC Technical Support Documents.

Next Steps

The U.S. government committed to updating the current estimates as the science and economic understanding of climate change and its impacts on society improves over time. For example, EPA and Department of Energy also hosted a series of workshops to inform SCC development. The first workshop focused on conceptual and methodological issues related to integrated assessment modeling and valuing climate change impacts, along with methods of incorporating these estimates into policy analysis. The second workshop reviewed research on estimating impacts and valuing damages on a sectoral basis. Papers based on the presentations from both workshops were published in a special issue of Climatic Change (April 2013). In addition, EPA funded a workshop on discounting in September 2011 that invited world-recognized experts to discuss how the benefits and costs of regulations should be discounted for projects with long horizons. In particular, it explored what principles should be used to determine the rates at which to discount the costs and benefits of regulatory programs when costs and benefits extend over very long horizons.

EPA and other agencies continue to engage in research on modeling and valuation of climate impacts to improve these estimates.

[1] See http://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf
[2] See http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf