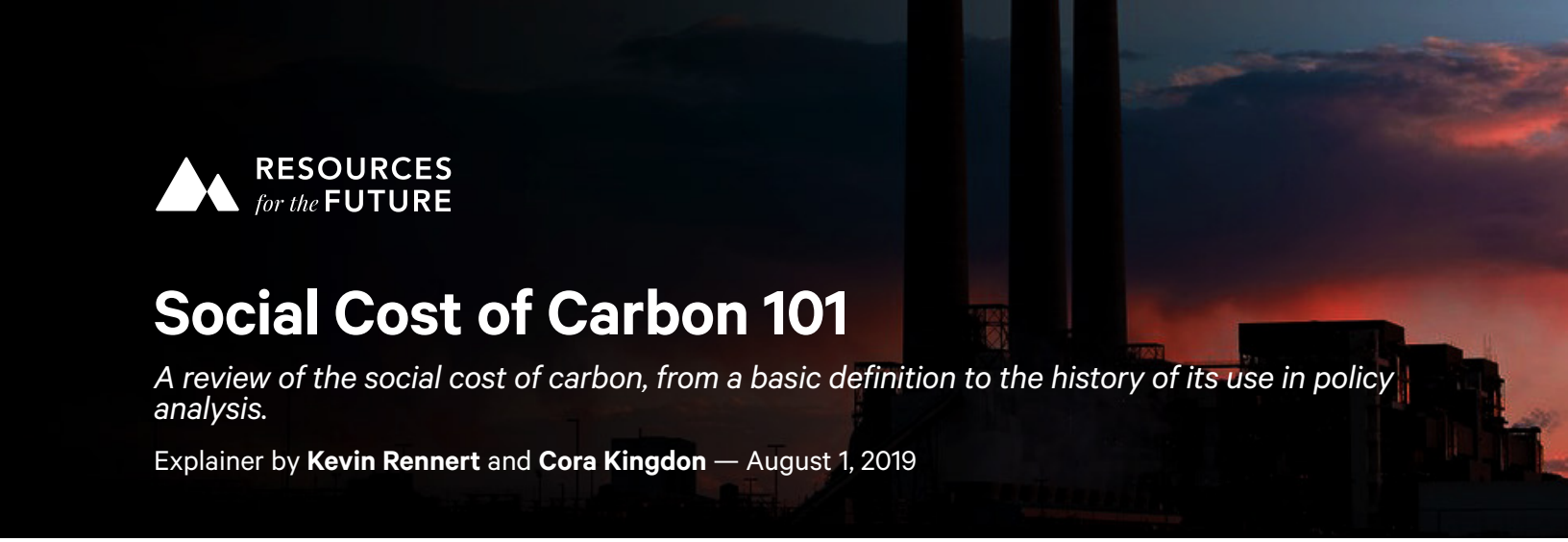


RESOURCES *for the* FUTURE

Social Cost of Carbon 101

A review of the social cost of carbon, from a basic definition to the history of its use in policy analysis.

Explainer by **Kevin Rennert** and **Cora Kingdon** — August 1, 2019

The **social cost of carbon** (SCC) is an estimate, in dollars, of the economic damages that would result from emitting one additional ton of greenhouse gases into the atmosphere. The SCC puts the effects of climate change into economic terms to help policymakers and other decisionmakers understand the economic impacts of decisions that would increase or decrease emissions. The SCC is currently used by local, state, and federal governments to inform billions of dollars of policy and investment decisions in the United States and abroad. This explainer reviews how the SCC is used in policy analysis, how it is calculated, and how it came to be.

How is the SCC Used in Policy Analysis?

One of the primary ways the SCC is used in policy design and evaluation is through benefit-cost analysis. A **benefit-cost analysis** compares the total economic benefits of a proposed policy to its total economic costs. Take, for example, a regulation that limits air pollution: its total benefits—including those from improvements to public health and the environment due to better air quality—would be compared against the implementation costs, such as the purchasing and installation of equipment to control air pollution. Benefit-cost analysis has been a **required part** of federal regulatory analysis since it was implemented by the Reagan administration in 1981.

The SCC is used in benefit-cost analysis to quantify the dollar-value of a policy's effect on climate change due to changes in greenhouse gas emissions. For policies that increase emissions, the expected increase in emissions (in tons) is multiplied by the SCC, and the result is included as part of the total estimated **costs** of the policy. For policies that decrease emissions, the change in emissions is multiplied by the SCC, and the result is added to the expected benefits of the policy.

Using the SCC to Calculate Costs and Benefits of Changing Emissions

In this example, the social cost of carbon has been calculated to be $50 per ton of CO_2.

How is the SCC Calculated?

Estimates of the SCC are calculated in four steps using specialized computer models.

- Step 1: Predict future emissions based on population, economic growth, and other factors.
- Step 2: Model future climate responses, such as temperature increase and sea level rise.
- Step 3: Assess the economic impact that these climatic changes will have on agriculture, health, energy use, and other aspects of the economy.
- Step 4: Convert future damages into their present-day value and add them up to determine total damages.

These four steps are completed to obtain a baseline value for the damages of emissions. Then, the modeling process is repeated with a small additional amount of emissions to see how much it changes the total cost of damages. The increase in damages from the additional emissions provides an estimate of the SCC. The model is then run hundreds of thousands of times to evaluate the uncertainty of the estimates.

Where Is the SCC Used Now?

The SCC is used across the entirety of the US federal government as part of required benefit-cost analysis of significant regulations and other actions (as described above). It is also used in **several states** and in a range of other decisionmaking contexts:

- In New York and Illinois, the SCC serves as the basis for the value of "zero-emission credits" paid to electric utilities under state clean energy legislation.
- In Colorado, Minnesota, and Washington, electric utilities are now required to use the federal SCC in their resource planning.
- In California, recent state legislation requires regulators to incorporate the SCC in policy analysis.
- The Canadian government has **adopted the estimation methodology**.
- The Mexican government is considering incorporating the SCC **into its policy analysis**.
- Several proposals for a federal carbon tax introduced by members of Congress suggest a starting tax level equal to the 2016 central case SCC.

SCC Calculation Considerations

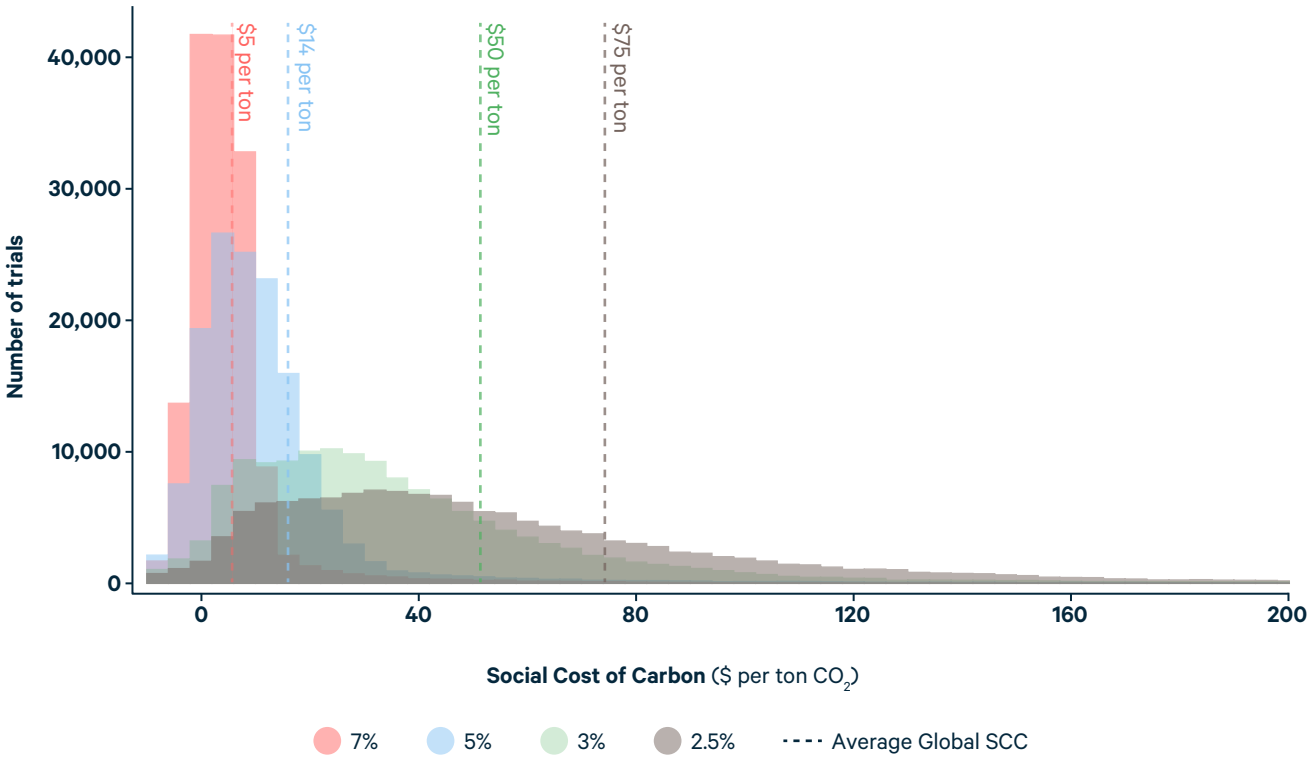
There are many modeling choices that affect the value of the SCC. The models are based on research and expertise from many different fields, such as climate science, demography, and economics. While these disciplines inform the scientific and research-based modeling decisions that are necessary for calculating the SCC, some parts of the calculation also require researchers to make assumptions that contain value judgements. Additionally, the modeling must incorporate information that is inherently uncertain, such as projections of future economic growth.

Discount Rate

The **discount rate** used in estimating the SCC incorporates both empirical evidence and value judgements. In Step 4 of the SCC modeling process described above, future damages are converted into present-day value by using a discount rate to determine how much weight is placed on impacts that occur in the future. Future costs and benefits are generally considered less significant than present costs and benefits, and the discount rate reflects this level of relative significance. A high discount rate means that future effects are considered much less significant than present effects, whereas a low discount rate means that they are closer to equally significant. The effects of different discount rates on estimates of the SCC can be seen in the table below. (Estimates of the SCC in 2020 published in the Affordable Clean Energy Rule Regulatory Impact Analysis. Units are 2019$ per ton of CO_2)

Discount Rate	Global SCC ($ per ton CO_2)	Domestic (US) SCC ($ per ton CO_2)
2.5%	75	10
3%	50	7
5%	14	2
7%	5	1

The Range of Values of the SCC



Global vs. Domestic

Another assumption made in SCC modeling is the geographic scope of the calculation; how SCC estimates with different geographic scopes are used in decisions also reflects value and policy judgements. In Step 3 of the SCC modeling process, the economic impacts can be calculated based on global damages (the total effects of emissions felt all around the world) or they can be limited to domestic damages (e.g., those felt within the United States). This choice significantly affects the outcome of SCC estimation, as shown in the table above.

Uncertainty

In calculating the SCC, it is necessary to make some assumptions that introduce uncertainty. For example, there is a range of plausible values for certain inputs to the SCC models, such as future economic growth rates and the magnitude of climate system responses. In order to account for this uncertainty, the models are run hundreds of thousands of times with different values for the uncertain variables and parameters. Given the range of uncertainty involved in this calculation, the SCC is best represented not as a single number, but as a range of possible values. For practical applications, however, a **central case value** is chosen, which is usually the average of all of the estimates for a given discount rate. Government analyses have also previously reported a "high impact scenario" in order to represent an upper-end indication of uncertainty in the estimates.

Policy Evolution of the SCC

While benefit-cost analyses have been required to assess the implications of economically significant regulations since the Reagan administration, the effects of greenhouse gases on climate change were not considered in these analyses until more recently. In 2008, the Center for Biological Diversity (CBD) **took the US government to court** over new fuel economy standards, arguing that by not accounting for future costs from climate change, policymakers had implicitly valued the costs of damages from climate change to be zero. The courts ruled in favor of the CBD, setting the legal requirement for the US government

to account for the costs and benefits of changes in greenhouse gas emissions in its economic analysis. The federal government employs the SCC to satisfy this requirement.

In the federal government's initial implementation of the SCC, government agencies and departments each developed and applied their own estimates. During the Obama administration, the Office of Management and Budget convened an Interagency Working Group on the Social Cost of Carbon (IWG) to develop a harmonized set of estimates to be applied consistently across the federal government. The group consolidated multiple models drawn from the academic literature and ran them over a range of standardized input scenarios in order to arrive at the federal government's estimates of the SCC. In 2016, the IWG turned to the National Academy of Science (NAS) for guidance on how best to improve, refine, and update their modeling process. In 2017, NAS published a **comprehensive report** laying out ongoing research priorities to ensure the SCC remains grounded in the best available science. The report's findings helped inform the development of Resources for the Future's **Social Cost of Carbon initiative**, which is stewarding a global team of distinguished scientists and economists working to advance the NAS's recommendations.

In 2017, President Trump signed **Executive Order 13783** which, among other actions, disbanded the Interagency Working Group on the Social Cost of Carbon and stated that the estimates generated by the Interagency Working Group were not representative of government policy. This executive order removed the requirement for individual government agencies to employ a harmonized set of SCC estimates in their regulatory analyses. In practice, rules proposed by a number of agencies after the issuance of Executive Order 13783 have relied on a set of interim estimates based on the same methodology and infrastructure as used by the Interagency Working Group, but with two modifications: calculating only damages occurring within the United States and employing discount rates of 3 percent and 7 percent for use in the primary analysis of regulations. Interagency Working Group estimates had previously reported global damage numbers and had employed discount rates of 2.5 percent, 3 percent, and 5 percent. These changes significantly alter SCC estimates, as depicted in the table of values above. For instance, the SCC for domestic economic impacts at a 7 percent discount rate would be $2.20 in the year 2050, while the SCC for global economic impacts at a 2.5 percent discount rate would be $100.62. These changes reflect both conceptual economic and policy judgements and have prompted substantial discussion. For example, RFF researchers have written **blogs** and **public comments** on the topic.

Resources for the Future (RFF) is an independent, nonprofit research institution in Washington, DC. Its mission is to improve environmental, energy, and natural resource decisions through impartial economic research and policy engagement.

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