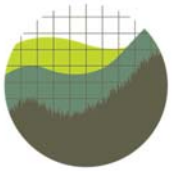


January 15, 2016

To: Forest Service; Council on Environmental Quality; Office of Information and Regulatory Affairs

Subject: Comments on Proposed Exception to the Colorado Roadless Rule (RIN 0596-AD26) and Supplemental Draft Environmental Impact Statement (November 2015)

Comments submitted by: Environmental Defense Fund, Institute for Policy Integrity at New York University School of Law, Natural Resources Defense Council, and Union of Concerned Scientists

Our organizations respectfully submit these comments regarding the Forest Service's analysis of the climate effects of its proposed exception to the Colorado Roadless Rule. Our organizations may separately and independently submit other comments regarding the proposed exception.

Though the Forest Service's choices to monetize greenhouse gas emissions and to use the Interagency Working Group's estimates of the Social Cost of Carbon in this supplemental environmental impact statement are appropriate and necessary, the agency's application of the metric is flawed in several key respects.

- Most importantly, the Forest Service's use of a 10th percentile estimate misunderstands the treatment of uncertainty and risk built into the Interagency Working Group's range of four estimates. Using a 10th percentile estimate is inconsistent with federal guidance and uniform agency practices, and it should not be used in this or any future environmental impact statements or regulatory analysis.
- While the Forest Service appropriately analyzes costs and benefits from a global perspective, it also gives equal attention to national and forest-only perspectives, which are inappropriate in the context of climate change and inconsistent with uniform agency practices.
- The Forest Service should adopt EPA's Social Cost of Methane methodology, or at least use methane's 20-year global warming potential and monetize carbon dioxide-equivalents in the main economic analysis. As the agency's own sensitivity analysis reveals, the costs associated with methane are significant enough to flip some net present value calculations from positive to negative.
- The Forest Service should abandon the assumption that all increased electricity from coal is perfectly offset by decreased electricity from other sources. This faulty assumption likely undercounts the net greenhouse gas emissions generated by this proposed action.
- Finally, the Forest Service must reconsider, under the principles of Executive Order 12,866, whether the benefits of this deregulatory action justify the significant social costs. Similarly, given that the action's social costs outweigh its benefits, and that the Forest Service has

declined to study potential mitigation measures such as methane capture and carbon offsets, the Forest Service should reconsider whether it has fulfilled its mandate under the National Environmental Protection Act (NEPA).

I. The Social Cost of Carbon and Social Cost of Methane Are Appropriate—and Often Necessary—Metrics to Use in This and Future Environmental Impact Statements

To achieve NEPA's goals of informing decisionmakers and the public, monetizing the costs and benefits of changes in greenhouse gas emissions is necessary for any environmental impact statement on major land and resource management decisions with substantial greenhouse gas effects. The Social Cost of Carbon and the Social Cost of Methane are peer-reviewed methodologies that harmonize the federal government's approach to climate change, and are the proper metrics for monetization. The Council on Environmental Quality (CEQ)'s draft guidance for greenhouse gas emissions, other agencies' practices, legal requirements, and economic principles all support using the Social Cost of Carbon and Social Cost of Methane in NEPA reviews of major land and resource management decisions.

CEQ Draft Guidance Supports Monetizing Major Greenhouse Gas Effects in NEPA Reviews

In December 2014, CEQ released revised draft guidance on how NEPA reviews should consider climate change. The revised guidance builds on an earlier 2010 draft and responds to the substantial public and inter-agency comments received on the 2010 draft.[1] The guidance strongly supports use of the Social Cost of Carbon and Social Cost of Methane in this environmental impact statement and in future NEPA reviews of similar projects.

Applicability: The CEQ draft guidance applies explicitly to "federal land and resource management decisions" as well as "site-specific actions" and "Federal rulemaking actions." The guidance specifically eliminates any exemption for resource management decisions.[2] Consequently, the Forest Service's proposed deregulatory exception to the Colorado Roadless Rule—as well as future natural resource extraction leases (and the Forest Service's consent thereto) or natural resource management actions with important climate effects—would be subject to CEQ's instructions on the consideration of climate change.

Scope and Scale: The CEQ draft guidance reminds agencies that NEPA reviews must include consideration of direct, indirect, and cumulative effects, including connected actions. In the context of climate change, therefore, NEPA requires appropriate consideration of upstream and downstream greenhouse gas emissions. CEQ specifically refers to the reasonably foreseeable effects of "using the [extracted] resource"[3]—that is, combustion or industrial use of any coal, gas, or oil extracted under a federal lease.

From the frame of direct, indirect, and cumulative climate effects, even individual and seemingly smaller resource management decisions can generate significant greenhouse gas emissions, warranting careful analysis. CEQ reminds that:

> Government action occurs incrementally, program-by-program and step-by-step, and climate impacts are not attributable to any single action, but are exacerbated by a series of

[1] CEQ, Announcement of *Revised Draft Guidance for Greenhouse Gas Emissions and Climate Change Impacts*, *available at* https://www.whitehouse.gov/administration/eop/ceq/initiatives/nepa/ghg-guidance.

[2] CEQ, *Revised Draft Guidance for Greenhouse Gas Emissions and Climate Change Impacts*, 1, n.2 (2014). The 2010 draft guidance had carved out an exception for natural resource management decisions, but as the 2014 draft guidance clarifies, that exception is not justified.

[3] *Id.* at 12.

> smaller decisions, including decisions made by the government. Therefore, the statement that emissions from a government action or approval represent only a small fraction of global emissions is more a statement about the nature of the climate change challenge, and is not an appropriate basis for deciding whether to consider climate impacts under NEPA.[4]

In fact, according to the draft guidance, projects with annual carbon dioxide-equivalent emissions above 25,000 metric tons presumptively warrant quantitative analysis.[5]

Monetization vs. Qualitative Discussion: Qualitative discussion of climate change, though important, is likely insufficient on its own to adequately inform decisionmakers and the public about the climate consequences of major resource management decisions. In particular, CEQ warns agencies "not [to] rely on boilerplate text to avoid meaningful analysis."[6] CEQ reminds agencies of the wide availability of easy-to-use tools for quantifying and monetizing greenhouse gas emissions.[7] On monetization specifically, the guidance recommends using the interagency Social Cost of Carbon tool, for a harmonized federal approach to climate change:

> Monetizing costs and benefits is appropriate in some, but not all, cases . . . . When an agency determines it appropriate to monetize costs and benefits, then, although developed specifically for regulatory impact analysis, the Federal social cost of carbon, which multiple agencies have developed and used to assess the costs and benefits of alternatives in rulemakings, offers a harmonized, interagency metric that can provide decisionmakers and the public with some context for meaningful NEPA review.[8]

Though the Environmental Protection Agency (EPA) released its estimates of the Social Cost of Methane after the CEQ guidance was published,[9] the logic of the CEQ guidance—that monetization is often appropriate, and that a harmonized, interagency metric is preferable—would apply with equal force to the use of the Social Cost of Methane in NEPA reviews.

Other Agencies Support Monetizing Climate Effects in NEPA Reviews

In the high-profile NEPA review of the Keystone XL Pipeline project, EPA called on the State Department to include a monetized estimate of the cost of anticipated greenhouse gas emissions, and in particular to use the Social Cost of Carbon.[10] Though the State Department failed to follow EPA's prudent advice, several other federal agencies have already begun using the Social Cost of Carbon protocol in NEPA reviews, including for land and resource management decisions. For example:

- The Office of Surface Mining Reclamation and Enforcement's Final Environmental Impact Statement for Four Corners Power Plant and Navajo Mine Energy Project (May 2015) applies the Social Cost of Carbon, though it chose not to monetize methane emissions after

[4] *Id.* at 9.

[5] *Id.* at 18.

[6] *Id.* at 5-6.

[7] *Id.* at 15.

[8] *Id.* at 16.

[9] Emission Guidelines, Compliance Times, and Standards of Performance for Municipal Solid Waste Landfills; Proposed Rule, 80 Fed. Reg. 52,100, 52,144 (Aug. 27, 2015).

[10] Letter from Cynthia Giles, Assistant Adm'r, U.S. Environmental Protection Agency, to Jose W. Fernandez & Dr. Kerri Anne Jones, U.S. Department of State (Apr. 22, 2013), at 2.

concluding that coal seam methane from the Navajo Mine would comprise less than 1 percent of the project's total carbon dioxide-equivalent emissions.[11]

- The Bureau of Land Management's Environmental Assessment for the Miles City Oil and Gas Lease Sale (May 2014) applies the Social Cost of Carbon.[12]
- The National Highway Traffic Safety Administration's Final Environmental Impact Statement for Fuel Efficiency Standards for Passenger Vehicles (July 2012) uses the Social Cost of Carbon (SCC), and uses relative global warming potentials to calculate the carbon dioxide-equivalent values for gases like methane, to monetize methane emissions in its SCC analysis.[13]

These examples prove that there are no conceptual, methodological, or practical barriers to applying the Social Cost of Carbon in NEPA reviews. Likewise, there are no barriers to, at a minimum, incorporating methane emissions into the SCC analysis by using carbon dioxide-equivalent values. Though the Social Cost of Methane is a newer metric and has not yet been incorporated into other agencies' environmental impact statements, the robustness of the approach, CEQ's guidance, and NEPA's "hard look" mandate all suggest that the Social Cost of Methane will be used in future NEPA reviews by other agencies, as it should be used by the Forest Service in this action.

NEPA May Require Monetizing Climate Costs, Especially If Benefits Have Been Monetized

NEPA requires "hard look" consideration of beneficial and adverse effects of each alternative option for major federal government actions. The U.S. Supreme Court has called the disclosure of impacts the "key requirement of NEPA," and held that agencies must "consider and disclose the actual environmental effects" of a proposed project in a way that "brings those effects to bear on [the agency's] decisions."[14] Though NEPA does not require a formal cost-benefit analysis,[15] agencies' approaches to assessing costs and benefits must be balanced and reasonable. In the litigation that triggered the Forest Service to revisit this exception to the Colorado Roadless Rule and the related environmental impact statement, the U.S. District Court for the District of Colorado explained that "[e]ven though NEPA does not require a cost-benefit analysis, it was nonetheless arbitrary and capricious to quantify the *benefits* of the lease modifications and then explain that a similar analysis of the *costs* was impossible when such an analysis was in fact possible."[16]

While often eschewing formal cost-benefit analysis in environmental impact statements, agencies typically include in their NEPA reviews of resource management decisions both quantitative and monetized analyses of the economic benefits and distributional effects of the decision, including estimated tons of recoverable resources per acre and the market value thereof; rental rates per acre and annual royalty rates; temporary and permanent job growth, including annual wages and indirect job effects form local expenditures; construction of infrastructure supporting the project;

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[11] *Available at* http://www.wrcc.osmre.gov/initiatives/fourCorners/documents/FinalEIS/Section%204.2%20-%20Climate%20Change.pdf; *see also* http://www.wrcc.osmre.gov/initiatives/fourCorners/documents/FinalEIS/Appendix%20A%20-%20Air%20Quality%20and%20Climate%20Change%20Information.pdf.

[12] Bureau of Land Management, Environmental Assessment DOI-BLM-MT-C020-2014-0091-EA, 76 (May 2014).

[13] *Available at* http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/FINAL_EIS.pdf at 9-77; *see also* http://ntl.bts.gov/lib/55000/55200/55224/Draft_Environmental_Impact_Statement_for_Phase_2_MDHD_Fuel_Efficiency_Standards.pdf.

[14] *Baltimore Gas & Elec. Co. v. Natural Res. Def. Council*, 462 U.S. 87, 96 (1983).

[15] 40 C.F.R. § 1502.23 ("[T]he weighing of the merits and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis.").

[16] *High Country Conservation Advocates v. Forest Service*, 52 F. Supp. 3d 1174, 1191 (D. Colorado, 2014).

and other related benefits.[17] As the District Court of Colorado concluded in the above case, "[i]t is arbitrary to offer detailed projections of a project's upside while omitting a feasible projection of the project's costs."[18] Thus, to the extent agencies continue to quantify and monetize many of the economic benefits and distributional effects of resource management decisions, agencies must also treat environmental costs with proportional analytical rigor.

Economic Principles Encourage Monetizing Climate Effects to Fulfill NEPA's Goals

NEPA's goals are to inform decisionmakers and the public by providing a "hard look" at the full range of environmental consequences of the government's proposed action and any feasible alternatives.[19] To inform decisionmakers and the public, NEPA reviews should aim to present information in the manner that most easily facilitates comparison across alternatives and that best avoids any information-processing biases that might distort rational decisionmaking. The economic literature supports monetizing climate effects to achieve these goals.

Monetization provides much-needed context for otherwise abstract consequences of climate change. If the NEPA review for an agency action merely quantifies greenhouse gas emissions by metric ton, or only qualitatively discusses the general effects of global climate change, decisionmakers and the public will tend to overly discount that individual action's potential contribution. Without context, it is difficult for many decisionmakers and the public to asses the magnitude and climate consequences of, for example, an additional million tons of carbon dioxide. Monetization, on the other hand, allows decisionmakers and the public to weigh all costs and benefits of an action—and to compare alternatives—using the common metric of money. Monetizing climate costs, therefore, better informs the public and helps "brings those effects to bear on [the agency's] decisions."[20]

The tendency to ignore non-monetized effects is the result of common but irrational mental heuristics like probability neglect and base-rate bias. Even sophisticated analysts can fall victim to these distortions, especially when combined with another bias: overconfidence in expertise. For example, the phenomenon of probability neglect causes people to reduce small probabilities entirely down to zero, resulting in these probabilities playing no role in the decisionmaking process.[21] This heuristic applies even to events with long-term certainty or with lower-probability but catastrophic consequences, so long as their effects are unlikely to manifest in the immediate future. Weighing the real risks that, decades or centuries from now, climate change will fundamentally and irreversibly disrupt the global economy, destabilize earth's ecosystems, or compromise the planet's ability to sustain human life is challenging; without a tool to contextualize such risks, it is far easier to ignore them. Monetization tools like the Social Cost of Carbon and Social Cost of Methane are designed to solve this problem: by translating long-term costs into present values, instantiating the harms of climate change and giving due weight to the potential of lower-probability but catastrophic harms.

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[17] *See, e.g.*, Forest Service, Federal Coal Lease Modifications COC-1362 & COC-67232, at pp. 190–91 (Aug. 2012); Forest Service, Pawnee National Grassland Oil and Gas Leasing Final Environmental Impact Statement 317, at 291–98 (Dec. 2014); Bureau of Land Mgmt., Final Environmental Impact Statement for the Wright Area Coal Lease Applications, ES-60-61, 4-130-50 (July 2010).

[18] *High Country*, 52 F. Supp. 3d. at 1195.

[19] *See Robertson v. Methow Valley Citizens Council*, 490 U.S. 332 (1989).

[20] *See Baltimore Gas & Elec. Co.*, 462 U.S. at 96.

[21] Cass R. Sunstein, *Probability Neglect: Emotions, Worst Cases, and Law* (John M. Olin Law & Economics, Working Paper No. 138, 2001), *available at* http://ssrn.com/abstract=292149.

Agencies and the public might also suffer from base-rate bias, which causes the undervaluation of information that is generally applicable across a range of scenarios.[22] Agencies fall into this trap when their NEPA reviews provide generic narrative descriptions of climate change yet conclude that climate change is too global and general a problem to address in a project-specific environmental impact statement. By conceding the long-run inevitability of climate change, agencies risk foreclosing the possibility of mitigating its effects. In contrast, metrics like the Social Cost of Carbon and Social Cost of Methane monetize the effects on climate change from the emission of as little as a single ton of carbon dioxide-equivalents.

Some critics insist that for resource and land management decisions, like coal leases, the cost of carbon would be "negligible" in relation to the "impacts from coal burned on a nationwide or global basis."[23] In other words, critics argue that the costs of such projects are too small to monetize. In fact, many resource management decisions have quite significant effects on greenhouse gas emissions: for example, the Bureau of Land Management recently approved coal lease expansions for mines that produce 20% of the country's coal supply.[24] Regardless, this argument about some projects being too small to monetize misunderstands the tools available for monetizing climate effects. The Social Cost of Carbon and Social Cost of Methane protocols were developed to assess the cost of actions with "marginal" impacts on cumulative global emissions,[25] and the metrics estimate the dollar figure of damages for one extra ton of greenhouse gas emissions.[26] This marginal cost is calculated using three integrated assessment models. The models translate emissions into changes in atmospheric greenhouse concentrations, atmospheric concentrations into changes in temperature, and changes in temperature into economic damages.[27] A range of plausible socio-economic and emissions trajectories are used.[28] The marginal cost is attained by first running the models using a baseline emissions trajectory, and then running the same models again with one additional unit of emissions. The difference in damages between the two runs is the marginal cost of one additional unit. The approach assumes that the marginal damages from increased emissions will remain constant for small emissions increases relative to gross global emissions.[29] In other words, the monetization tools are in fact perfectly suited to measuring the marginal effects of resource management decisions, as well as rulemakings.

The Social Cost of Carbon and Social Cost of Methane Are the Proper Metrics

The Social Cost of Carbon was developed collaboratively by multiple federal agencies (including the Forest Service's parent agency, the Department of Agriculture), through a comprehensive, science-based process, which has been thoroughly vetted and subject to repeated public comments.[30] The

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[22] *See* Fallacy Files, *The Base Rate Fallacy*, http://www.fallacyfiles.org/baserate.html (last accessed Feb. 15, 2015); *see also* David B. Graham, Capt. Thomas D. Johns, *The Corporate Emergency Response Plan: A Smart Strategy*, 27 NAT. RESOURCES & ENV'T 3 (2012) (on normalcy bias).

[23] *See, e.g.*, Bureau of Land Management, West Antelope II South Lease Modification Decision (Aug. 2014).

[24] *See* Bureau of Land Mgmt., Final Environmental Impact Statement for the Wright Area Coal Lease Applications, ES-60-61, 4-130-50 (July 2010).

[25] Interagency Working Group on Social Cost of Carbon, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12,866*, 1 (2010) [hereinafter 2010 TSD].

[26] EPA, The Social Cost of Carbon, http://www.epa.gov/climatechange/EPAactivities/economics/scc.html (last visited Feb. 11, 2015).

[27] 2010 TSD, *supra* note 25, at 5.

[28] *Id.* at 15.

[29] *Id.* at 1.

[30] *Id.* The Interagency Working Group was made up of technical experts from many agencies, including the Department of Agriculture (which houses the Forest Service), Council of Economic Advisers, Council on Environmental Quality, National Economic Council, Office of Energy and Climate Change, Office of Management and Budget, Office of

White House convened an Interagency Working Group on the Social Cost of Carbon in 2009, to develop uniform estimates to harmonize analysis of climate change across the federal government.[31] Following the U.S. Court of Appeals for the Ninth Circuit's reprimand in *Center for Biological Diversity v. National Highway Traffic Safety Administration* that "while . . . there is a range of values, the value of carbon emissions reduction is certainly not zero,"[32] various federal agencies used an assortment of individually developed estimates in their regulatory analyses.[33] The Interagency Working Group's mandate from the Administration was to resolve the wide variance in the agencies' independently developed estimates by establishing uniform values.[34]

The Interagency Working Group met on a regular basis to explore technical literature in relevant fields, consider public comments, and discuss key model inputs and assumptions.[35] The U.S. Government Accountability Office recently praised the Group's transparent and scientific approach, finding that it relied on existing academic literature and models; used consensus-based decision-making; and took steps to disclose limitations and incorporate new information.[36] Since the Interagency Working Group published its results in 2010, dozens of proposed regulatory actions have incorporated the estimates, all subject to public comment.[37] The Office of Management and Budget also coordinated a general call for comments on the Interagency Working Group's methodology, and the Group has now responded to all public comments received during that process.[38] The Interagency Working Group plans to regularly update its estimates.[39]

Though the Working Group's charge was to develop Social Cost of Carbon estimates for use in regulatory impact analyses, the methodology used is in no way unique to the regulatory process. There is no reason to believe that the estimates would be any different if developed specifically for the context of NEPA reviews or resource management decisions. Agencies have used other metrics designed originally for regulatory impact analysis in their environmental impact statements as well. For example, after the Nuclear Regulatory Commission developed an estimate of the monetary value of radiological exposure for use in the agency's regulatory analyses, the U.S. Court of Appeals for the Third Circuit directed NRC in 1989 "to consider severe accident mitigation design alternatives as part of the NRC's environmental review process under the National Environmental Protection Act (NEPA). . . . [T]he staff used the $1000 per person-rem value [of the consequences of radiological exposure] as a screen to compare values and impacts [in those NEPA reviews]."[40]

Science and Technology Policy, Department of Commerce, Department of Transportation, Environmental Protection Agency, and Department of the Treasury.

[31] *See* U.S. Gov't Accountability Office, *Regulatory Impact Analysis: Development of Social Cost of Carbon Estimates*, GAO-14-663 at 5 (July 2014).

[32] 538 F.3d 1172, 1200 (9th Cir. 2008) (invalidating an EIS prepared, pursuant to the National Environmental Protection Act, by the National Highway Transportation Safety Administration, which had measured and monetized a wide array of potential costs and benefits of a rule, but had failed to monetize the benefits which would accrue from decreased carbon emissions).

[33] *See* GAO, *supra* note 31, at 5.

[34] *See* 2010 TSD, *supra* note 25, at 1.

[35] *See id.* at 2.

[36] *See* GAO, *supra* note 31.

[37] *See id.* at 6.

[38] Interagency Working Group, *Response to Comments: Social Cost of Carbon for Regulatory Impact Analysis* (July 2015), https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-response-to-comments-final-july-2015.pdf.

[39] Interagency Working Group, *Technical Update on the Social Cost of Carbon for Regulatory Impact Analysis* 4 (May 2013) ("the interagency group recommended in 2010 that the SCC estimates be revisited on a regular basis or as model updates that reflect the growing body of scientific and economic knowledge become available").

[40] Nuclear Regulatory Commission, NUREG-1530, *Reassessment of NRC's Dollar Per Person-Rem Conversion Factor Policy* 3 (1995), *available at* http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/27/048/27048008.pdf;

The Interagency Working Group has, to date, focused exclusively on carbon dioxide. The Social Cost of Carbon can be roughly adjusted to approximate the costs of other greenhouse gases by multiplying by the relative global warming potential of those gases. Scientists, however, have long argued that the full social costs of specific, non-carbon dioxide gases like methane should be assessed through separate methodologies, which would more accurately account for varying atmospheric life spans, among other differences.[41] At least a dozen published studies, dating back to 1993, have estimated the social cost of non-carbon dioxide greenhouse gases, including methane.[42]

EPA has developed Social Cost of Methane estimates based on one of the most recent peer-reviewed articles: Marten *et al*.[43] Marten *et al*. builds on the methodology used by the Interagency Working Group to develop the SCC. The study maintains the same three integrated assessment models, five socioeconomic-emissions scenarios, equilibrium climate sensitivity distribution, three constant discount rates, and aggregation approach that were agreed upon by the Interagency Working Group. Consequently, most key assumptions underlying the Social Cost of Methane estimates have already gone through a transparent, consensus-driven, publically reviewed, regularly updated process, since they were borrowed from the Interagency Working Group's thoroughly vetted methodology. Marten *et al*. was not only published in a peer-reviewed economics journal, but EPA undertook additional internal and peer review of the approach.[44] Marten *et al*.'s estimates thus are reasonable measurements of the Social Cost of Methane, appropriate for use in NEPA reviews.

II. The Forest Service's Application of a 10th Percentile Estimate Misunderstands the SCC's Treatment of Uncertainty and Is Inconsistent with Federal Practices

The Interagency Working Group on the Social Cost of Carbon—which included representatives from the Forest Service's parent agency, the Department of Agriculture—carefully developed a range of four Social Cost of Carbon values intended for uniform use across all federal agency analyses. Three values reflected a range of discount rates: 5%, 3%, and 2.5%. The fourth value was intended to "represent the higher-than-expected impacts from temperature change further out in the tails of the SCC distribution"[45]—in other words, to account for the risk of catastrophic damages that the underlying models do not fully capture. To approximate a value reflecting such lower-probability catastrophic risks, the Interagency Working Group selected the 95th percentile value at a 3% discount rate as the fourth and final estimate. This range of four estimates reflects the best available scientific and economic literature and has been thoroughly subject to peer review and public comment.

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see also NRC, NUREG-1437, *Draft Report: Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 55* at F-34 (2015) (using the monetary value of public health risk); *see also* NHTSA's 2012 EIS on vehicle efficiency standards, *supra* note 13, at 4-26 (using EPA's value of statistical life).

[41] *See* Disa Thureson & Chris Hope, *Is Weitzman Right? The Social Cost of Greenhouse Gases in an IAM World* 21 (Örebro University-Swedish Business School Working Paper 3/2012).

[42] *See, e.g.*, Alex L. Marten et al., *Incremental CH4 and N2O Mitigation Benefits Consistent With the US Government's SC-CO2 Estimates,* Climate Policy 7 (2014) (describing eleven prior studies estimating the social cost or global damage potential associated with methane).

[43] *Id.*

[44] EPA, *Whitepaper on Valuing Methane Emissions Changes in Regulatory Benefit-Cost Analysis, Peer Review Charge Questions , and Responses* (2015), *available at* http://www3.epa.gov/climatechange/pdfs/social%20cost%20methane%20white%20paper%20application%20and%20peer%20review.pdf.

[45] 2010 TSD, *supra* note 25, at 3.

Now, without adequate justification, consultation with other agencies, or even full disclosure of its methodology,[46] the Forest Service on its own initiative proposes adding a fifth and distinctly lower estimate: a 10th percentile value at the 3% discount rate. The Forest Service asserts its aims are "to provide a lower bound," "to 'complete' the range of SCC values," and to counterbalance the 95th percentile estimate.[47] This choice misunderstands the nature and purpose of the Interagency Working Group's range of four values in general, and of the 95th percentile estimate in particular; it contradicts the Office of Information and Regulatory Affair's guidance on best practices for handling uncertainty, risk aversion, and probability distributions; and it undermines the uniform, government-wide approach to climate analysis.

There is no economic foundation for the Forest Service's choice to include a 10th percentile estimate in a misguided attempt to balance out the 95th percentile estimate and "complete" the range. The 95th percentile value does not intend to show the probability distribution around the 3% discount rate specifically, but rather serves as a methodological approach to approximating the "higher-than-expected impacts from temperature change further out in the tails of the SCC distribution." The shape of the distribution of climate risks and damages includes a long tail of lower-probability, high-damage, irreversible outcomes, due to "tipping points" in planetary systems, inter-sectoral interactions, and other deep uncertainties.[48] Climate damages are not normally distributed around a central estimate, but rather feature a significant right skew toward catastrophic outcomes. In fact, a recent survey of economic experts concludes that catastrophic outcomes increasingly seem likely to occur.[49] The integrated assessment models used to calculate the Social Cost of Carbon are unable to systematically account for these potential catastrophic outcomes. Instead, the Interagency Working Group included the 95th percentile value to account for such uncertainty.[50] As the Interagency Working Group has explained, there are no similarly systematic biases pointing in the other direction which might warrant including a low-percentile estimate.[51]

The 95th percentile also addresses the strong possibility of widespread risk aversion with respect to climate change. As the Working Group explained:

> A key question unanswered during this interagency process is what to assume about relative risk aversion with regard to high-impact outcomes. These calculations do not take into account the possibility that individuals may have a higher willingness to pay to reduce the likelihood of low probability, high-impact damages than they do to reduce the likelihood of higher-probability but lower impact damages with the same expected cost. (The inclusion of the 95th percentile estimate in the final set of SCC values was largely motivated by this

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[46] The Forest Service never even transparently discloses what the 10th percentile estimate is; Table E-14 of Input Values, SDEIS for Colorado Roadless Areas, has blank columns along the row labeled "3% 10th." *Compare* Office of Management & Budget, *Circular A-4* at 39 (2003) ("Any data and models that you use to analyze uncertainty should be fully identified.").

[47] SDEIS at 85. Though the Forest Service claims it limits use of the 10th percentile estimate to the global perspective, *see* SDEIS Table 3-21 ("using all the SCC values except . . . 10th percentile SCC values in Forest or National Boundary stances"), but given that the global perspective is the only rational context for climate change (see next section), the limitation is meaningless.

[48] 2010 TSD, *supra* note 25, at 31.

[49] Policy Integrity, *Expert Consensus on the Economics of Climate Change* 2 (2015), *available at* http://policyintegrity.org/files/publications/ExpertConsensusReport.pdf ("Experts believe that there is greater than a 20% likelihood that this same climate scenario would lead to a 'catastrophic' economic impact (defined as a global GDP loss of 25% or more).").

[50] 2010 TSD, *supra* note 25, at 30.

[51] Interagency Working Group, *Response to Comments: Social Cost of Carbon for Regulatory Impact Analysis*, *supra* note 38, at 26-27 (specifically rejecting a 5th percentile estimate).

> concern.) . . . Even if individuals are not risk-averse for such scenarios, it is possible that regulatory policy should include a degree of risk-aversion.[52]

In short, the 95th percentile estimate attempts to capture risk aversion and uncertainties around lower-probability, high-damage, irreversible outcomes that are currently omitted or undercounted by the models. There is no need to "balance" out this estimate with a low-end 10th percentile value, because the reverse assumptions are not reasonable:

- There is no reason to believe the public or the government will be systematically risk seeking with respect to climate change.[53]
- The consequences of overestimating the risk of climate damages (i.e., spending more than we need to on mitigation and adaptation) are likely not nearly as irreversible as the consequences of underestimating the risk of climate damage (i.e., failing to prevent catastrophic outcomes).
- Though some uncertainties might point in the direction of lower Social Cost of Carbon values, such as uncertainties around the development of breakthrough adaptation technologies, the models already account for such uncertainties around adaptation;[54] on balance, most uncertainties point toward higher, not lower, Social Cost of Carbon estimates.[55]
- There is no empirical basis for any "long tail" of potential benefits that would counteract the potential for extreme harm associated with climate change. The 95th percentile has been explicitly included by the Interagency Working Group to account for systematic omissions that bias the Social Cost of Carbon downwards, including the models' inability to account for risk aversion, option value, catastrophic outcomes, and other omitted damages. As the Interagency Working Group explained, "In contrast, [we are] not aware of systematic upward biases in the estimates comparable to the downward biases discussed above. For this reason, while [we have] been fully transparent regarding the entire range of uncertainty reflected in the probability distributions, we did not include a 5th percentile estimate in the selected range for regulatory impact analysis."[56]

Furthermore, the 10th percentile value has no support in the community of experts on climate economics, as it falls far below the Social Cost of Carbon estimates that most experts recommend. The Interagency Working Group's estimates already reflect a "full range" of values: a low estimate (the 5% discount rate), a "central" estimate (the average value at the 3% discount rate), a high estimate (the 2.5% discount rate), and an estimate that accounts for uncertainty and risk (the 95th percentile of the 3% discount rate).[57] There is no need for the Forest Service to "provide a lower bound," because it already exists: namely, the 5% discount rate estimate. Indeed, if anything the 5% discount rate is already too conservative as a lower-bound estimate. A recent survey of 365 experts on the economics of climate change found that 90% of experts believe a 3% discount rate or lower

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[52] 2010 TSD, *supra* note 25, at 30.

[53] As a 2009 survey revealed, the vast majority of economic experts support the idea that "uncertainty associated with the environmental and economic effects of greenhouse gas emissions increases the value of emission controls, assuming some level of risk-aversion." *See Expert Consensus, supra* note 49, at 3 (citing 2009 survey).

[54] *E.g.,* 2010 TSD, *supra* note 25, at 8 (discussing consideration of adaptation in the FUND model); *but see id.* at 29-30 (on inability to accurately forecast adaptation, but suggesting uncertainty whether the incomplete treatment of adaptation and technology leads to understating or overstating the likely damages).

[55] *See* Richard L. Revesz et al., *Global Warming: Improve Economic Models of Climate Change*, 508 NATURE 173 (2014).

[56] Interagency Working Group, *Response to Comments: Social Cost of Carbon for Regulatory Impact Analysis*, *supra* note 38, at 26-27.

[57] 2010 TSD, *supra* note 25, at 3.

is appropriate for climate change; a 5% discount rate falls on the very high end of what experts would recommend.[58] Only 8% of the experts surveyed believe that the Social Cost of Carbon should be valued below the Interagency Working Group's central estimate of $37, and 69% of experts believed the value should be at or above the central estimate of $37.[59] Moreover, all four estimates of the Social Cost of Carbon are likely underestimated because the models currently omit many significant categories of damages—such as economic growth, pests, pathogens, erosion, air pollution, fire, energy supply, health costs, political conflict, and ocean acidification—and because of other methodological choices.[60] The Social Cost of Carbon estimate derived from the 5% discount rate is clearly on the lower end of what most economic experts would currently support; there would be little to no support among economic experts for the even lower estimate the Forest Service now invents.

Finally, the Forest Service's use of a 10th percentile estimate contradicts the guidance on best practices for economic analysis issued by the Office of Information and Regulatory Affairs (OIRA). As OIRA summarized in 2011, "The goal is not to characterize the full range of *possible* outcomes . . . but rather the range of *plausible* outcomes."[61] In *Circular A-4*, OIRA explains that:

> It is a common practice to compare the 'best estimates' of both benefits and costs with those of competing alternatives. These 'best estimates' are usually the average or the expected value of benefits and costs. Emphasis on these expected values is appropriate as long as society is 'risk neutral' with respect to the regulatory alternatives.[62]

OIRA also recommends comparing the best estimates of both costs and benefits. A 10th percentile value for climate damage biases the Forest Service's comparison of costs and benefits in a way that will mislead decisionmakers and the public: there is, for example, no 10th percentile estimate of the calculation of benefits of coal production. The Forest Service cannot cherry-pick central estimates of benefits and low estimates of costs as it suits them, nor can they compare apples and oranges.

To maintain consistency across the federal government's analyses of climate change, the Forest Service should defer to the Interagency Working Group's instructions on applying the Social Cost of Carbon, and should stick to the established range of four estimates.

III. The Global Perspective Is Appropriate; the National and Forest-Only Perspectives Are Misleading and Irrational in the Context of Climate Change

In weighing the costs and benefits of the rule, the Forest Service explains that: "If concerns are limited to potential GHG damages to the U.S. population, the proposed action is acceptable (or neutral). If decisions account for . . . populations outside the U.S., . . . no-action might be the preferred alternative."[63] This statement suggests a misunderstanding of the application of the global Social Cost of Carbon and Social Cost of Methane estimates to U.S. government decisionmaking. The global estimates are not simply intended to internalize into U.S.

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[58] *Expert Consensus, supra* note 49, at 21; *see also* Drupp, M.A., et al. *Discounting Disentangled: An Expert Survey on the Determinants of the Long-Term Social Discount Rate* (London School of Economics and Political Science Working Paper, May 2015) (finding consensus on social discount rates between 1-3%).

[59] *Expert Consensus, supra* note 49, at 18.

[60] *See* Revesz et al., *supra* note 55; Peter Howard, *Omitted Damages: What's Missing from the Social Cost of Carbon* (Cost of Carbon Project Report, 2014); Frances C. Moore & Delavane B. Diaz, *Temperature Impacts on Economic Growth Warrant Stringent Mitigation Policy*, 5 NATURE CLIMATE CHANGE 127 (2015) (demonstrating SCC may be biased downward by more than a factor of six by failing to include the climate's effect on economic growth).

[61] *Circular A-4 Primer*,14-15 (2011).

[62] *Circular A-4,* 42 (2003).

[63] SDEIS at 100.

decisionmaking the climate effects that U.S. actions impose on non-U.S. populations; rather, as explained in this section, the U.S. government has adopted global Social Cost of Carbon and Social Cost of Methane estimates as part of a strategy to motivate reciprocal actions by foreign countries that will directly benefit U.S. populations.

To avoid a global "tragedy of the commons" that could irreparably damage all countries, including the United States, every nation should set policy according to global Social Cost of Carbon and Social Cost of Methane values.[64] Climate and clean air are global common resources, meaning they are freely available to all countries, but any one country's use—i.e., pollution—imposes harms on the polluting country as well as the rest of the world. Because carbon pollution does not stay within geographic borders but rather mixes in the atmosphere and affects climate worldwide, each ton of carbon emitted by the United States not only creates domestic harms, but also imposes large externalities on the rest of the world. Conversely, each ton of carbon abated in another country benefits the United States along with the rest of the world.

If all countries set their carbon emission levels based on only domestic costs and benefits, ignoring the large global externalities, the aggregate result would be substantially sub-optimal climate protections and significantly increased risks of severe harms to all nations, including the United States. Thus, basic economic principles demonstrate that the United States stands to benefit greatly if all countries apply global Social Cost of Carbon and Methane values in their regulatory decisions. Indeed, the United States stands to gain hundreds of billions or even trillions of dollars in direct benefits from efficient foreign action on climate change.[65]

A rational tactical option in the effort to secure that economically efficient outcome is for the United States to continue using global Social Cost of Carbon and Methane values itself.[66] The United States is engaged in a repeated strategic game of international negotiations and regulatory coordination, in which several significant players—including the United States, England, Norway, and France—have already adopted a global framework.[67] For example, Canada and Mexico have explicitly borrowed the U.S. estimates of a global Social Cost of Carbon to set their own fuel efficiency standards.[68] For the United States to now depart from this collaborative dynamic by reverting to a domestic-only SCC estimate could undermine the country's long-term interests in climate

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[64] *See* Garrett Hardin, *The Tragedy of the Commons*, 162 Science 1243 (1968) ("[E]ach pursuing [only its] own best interest . . . in a commons brings ruin to all.").

[65] Policy Integrity, *Foreign Action, Domestic Windfall: The U.S. Economy Stands to Gain Trillions from Foreign Climate Action* (2015), http://policyintegrity.org/files/publications/ForeignActionDomesticWindfall.pdf

[66] *See* Robert Axelrod, *The Evolution of Cooperation* 10-11 (1984) (on repeated prisoner's dilemma games).

[67] *See* ECONOMICS GROUP, DEFRA, U.K., THE SOCIAL COST OF CARBON AND THE SHADOW PRICE OF CARBON: WHAT THEY ARE, AND HOW TO USE THEM IN ECONOMIC APPRAISAL IN THE UK 1 (2007); *see also* Ministry of Finance, Norway, Cost-Benefit Analysis: Carbon Price Paths, *available at* http://www.regjeringen.no/en/dep/fin/Documents-and-publications/official-norwegian-reports-/2012/nou-2012-16-2/10.html?id=713585 ("The United Kingdom has changed its method for the valuation of greenhouse gas emissions. Prior to 2009, the estimated global social cost of carbon was used, but one [sic] has now switched over to pricing in line with the necessary marginal cost of meeting long-term domestic emission reduction targets in conformity with the EU Climate and Energy Package."); Balázs Égert, *France's Environmental Policies: Internalising Global and Local Externalities* 8-10 (OECD Economics Department Working Papers No. 859, 2011), *available at* http://dx.doi.org/10.1787/5kgdpn0n9d8v-en (discussing global impacts and France's history of calculating the SCC).

[68] *See* Heavy-Duty Vehicle and Engine Greenhouse Gas Emission Regulations, SOR/2013-24, 147 Can. Gazette pt. II, 450, 544 (Can.), *available at* http://canadagazette.gc.ca/rp-pr/p2/2013/2013-03-13/html/sor-dors24-eng.html ("The values used by Environment Canada are based on the extensive work of the U.S. Interagency Working Group on the Social Cost of Carbon."); Instituto Nacional de Ecología, Mexico, Regulatory Impact Analysis on *PROY-NOM-163- SEMARNAT-ENER-SCFI-2012, Emisiones de bióxido de carbono (CO_2) provenientes del escape y su equivalencia en términos de rendimiento de combustible, aplicable a vehículos automotores nuevos de peso bruto vehicular de hasta 3857 kilogramos* (July 5, 2012), *available at* http://207.248.177.30/mir/formatos/defaultView.aspx?SubmitID=273026.

negotiations and could jeopardize emissions reductions underway in other countries, which are already benefiting the United States.

Negotiation is key to the President's constitutional foreign affairs powers, and the Supreme Court has "recognized the special importance of our nation speaking with one voice."[69] The development and analysis of U.S. regulations are essential parts of the dialogue between the United States and foreign countries about climate change. Through the Interagency Working Group, the President has instructed all federal agencies to use a global Social Cost of Carbon value as one important step in negotiations to encourage other countries to take reciprocal actions that also account for global externalities. As the Interagency Working Group explained, "Emphasizing the need for a global solution to a global problem, the United States has been actively involved in seeking international agreements to reduce emissions. . . . When these considerations are taken as a whole, the interagency group concluded that a global measure of the benefits from reducing U.S. emissions is preferable."[70] If different agencies use different Social Cost of Carbon and Methane values in assessing and setting regulatory policies, it would risk sending mixed signals to the international community. The President's constitutional powers to negotiate international agreements would be seriously impaired if federal agencies stop relying on a single, harmonized, global Social Cost of Carbon value.

Finally, global Social Cost of Carbon and Methane values are in the national interest because harms experienced by other countries could significantly affect the United States. Climate damages in one country could generate large spillover effects to which the United States is especially vulnerable. As seen historically, economic disruptions in one country can cause financial crises that reverberate globally at a breakneck pace. Similarly, national security analysts increasingly emphasize that the geopolitical instability associated with climatic disruptions abroad poses serious threats to the United States.[71] A global framework properly recognizes that climate change will threaten the United States with significant and shifting international spillover effects.

Moreover, because the current models do not account for inter-regional spillover effects, the "provisional and highly speculative" range of domestic-only benefits that the Interagency Working Group tentatively approximated (i.e., 7-23% of the global value) is almost certainly an underestimate, as the Working Group readily acknowledges.[72] Basing national-only and forest-only perspectives on this speculative, underestimated range and presenting such calculations alongside and on equal footing with the global perspective is deeply misleading.

NEPA further supports a global perspective on costs and benefits of climate change. In a provision on "International and National Coordination of Efforts," NEPA states that "all agencies of the Federal Government *shall* . . . recognize the worldwide and long-range character of environmental problems."[73] Using global Social Cost of Carbon and Methane values to analyze and set policy is consistent with these instructions. Furthermore, NEPA requires agencies to, "where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of mankind's world environment."[74] As explained above, using the global values

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[69] *See Made in the USA Found. v. United States*, 242 F.3d 1300, 1317-18 (11th Cir. 2001) (explaining the Supreme Court's holding in *Baker v. Carr,* 369 U.S. 186, 211 (1962)).

[70] 2010 TSD, *supra* note 25, at 11-12

[71] *See, e.g.*, Department of Defense, Climate Change Adaptation Roadmap (2014); CNA Military Board, National Security and the Accelerating Risks of Climate Change (2014).

[72] 2010 TSD, *supra* note 25, at 11.

[73] 42 U.S.C. § 4332(2)(f) (emphasis added).

[74] *Id.*; *see also* Environmental Defense Fund v. Massey, 986 F.2d 528, 535 (D.C. Cir. 1993) (confirming that Subsection F is mandatory); Natural Resources Defense Council v. NRC, 647 F.2d 1345, 1357 (D.C. Cir. 1981) ("This NEPA

supports the federal government's strategy to encourage international cooperation on climate change.

In general, the national-only and forest-only perspectives are inapt for an action with significant climate consequences; the forest-only perspective is particularly irrational. The forest boundary is an arbitrary place to draw a line: what would stop an agency from narrowing the scope of analysis even further, to just the confines of the coal mine itself? NEPA requires a "hard look" at the full range of direct, indirect, and cumulative effects of a proposed federal action and any connected actions. Including an analysis that entirely ignores the significant climate costs experienced beyond the edges of a single forest violates the goals of NEPA to inform the public and decisionmakers.

The forest-only analysis is also irrationally biased, since the presentation of benefits already reflects global market forces. Just as coal has no real value within the exclusive confines of the forest boundary, and only acquires its value upon interaction with global market forces, it is meaningless to talk about climate effects "within the forest boundary," when climate change is a global phenomenon of inter-connected planetary systems, ecosystems, and economies.[75] Commodities markets are globalized and integrated, and the price for coal (its value) is based on global supply and demand. As such, the Forest Service necessarily is using a globally-set price to determine the benefits of this proposed action. The agency should likewise use the globally-determined value for the costs of its proposal.

(Finally, there appears to be a typographical error in table 3-21. On page 99 of the SDEIS, the Forest Service says that national benefits and global benefits are identical, but in the table the upper estimates for each of those two scenarios do not match ($2,410 vs $2,614).)

IV. The Forest Service Should Adopt EPA's Social Cost of Methane Methodology, or at least Use Methane's 20-Year Global Warming Potential to Monetize Its Effects

The Forest Service claims that it is required to consider only carbon dioxide emissions because "the SCC guidelines from the U.S. Interagency Working Group has only considered estimates for the SCC."[76] Nevertheless, in its sensitivity analysis, the Forest Service converts methane emissions to carbon dioxide-equivalent amounts using the relative 100-year global warming potential, and finds that including methane has a significant effect on its present net value calculations, changing the sign from positive to negative in some cases (though, notably, the Forest Service does not disclose the full calculations in its sensitivity analysis).[77]

There is no reason for the Forest Service to relegate this important analysis of methane to the sensitivity analysis; methane should be monetized in the main economic analysis, together with carbon dioxide. As shown above, other agencies have already begun considering carbon dioxide-

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prescription, I find, looks toward cooperation, not unilateral action, in a manner consistent with our foreign policy."); *cf.* COUNCIL ON ENVIRONMENTAL QUALITY, GUIDANCE ON NEPA ANALYSIS FOR TRANSBOUNDARY IMPACTS (1997), *available at* http://www.gc.noaa.gov/documents/transguide.pdf; CEQ, DRAFT NEPA GUIDANCE ON CONSIDERATION OF THE EFFECTS OF CLIMATE CHANGE AND GREENHOUSE GAS EMISSIONS at 2 (2010), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ceq/20100218-nepa-consideration-effects-ghg-draft-guidance.pdf (defining climate change as a "global problem"); Exec. Order No. 12,114, *Environmental Effects Abroad of Major Federal Actions*, 44 Fed. Reg. 1957 §§ 1-1, 2-1 (Jan. 4, 1979) (applying to "major Federal actions . . . having significant effects on the environment outside the geographical borders of the United States," and enabling agency officials "to be informed of pertinent environmental considerations and to take such considerations into account . . . in making decisions regarding such actions").

[75] The forest boundary perspective especially makes little sense since the Forest Service is not monetizing the methane released within the forest from mining activity.

[76] SDEIS at 85.

[77] SDEIS at E-25.

equivalent tons of methane in their NEPA reviews. More importantly, EPA has now developed a sophisticated methodology for directly estimating the Social Cost of Methane. EPA's Social Cost of Methane estimates are derived from the peer-reviewed literature, are currently undergoing public comment, and should be considered by all agencies in future regulatory analysis and environmental impact statements for actions with major effects on methane emissions. (See *supra* for more support for the Social Cost of Methane.)

If the Forest Service for some reason declines to follow EPA's approach on the Social Cost of Methane, it could still use methane's relative global warming potentials to convert methane emissions to carbon dioxide-equivalents and monetize them as a less accurate, lower-bound estimate. However, instead of only using the 100-year global warming potential value for methane of 36, the Forest Service should also consider the Intergovernmental Panel on Climate Change's estimate of methane's relative global warming potential over a 20-year period: specifically, 85 to 87 times greater than carbon dioxide (after making the recommended adjustment for fossil methane).[78] Given the short life of methane, the Forest Service should at least conduct sensitivity analysis over the entire global warming potential range, instead of merely utilizing the lower 100-year timescale range. Again, though, the Social Cost of Methane approach is the more reasonable and preferred way to value this rule's important methane reductions.

V. The Forest Service Should Abandon the Assumption that All Increased Electricity from Coal Is Perfectly Offset by Decreased Electricity from Other Sources

The model used by the Forest Service assumes "fixed demand" such that "changes in aggregate electricity generation across energy sources are assumed to be zero."[79] This assumption defies basic economic principles, which would predict that increases in supply will decrease price and so increase consumption. To the extent that additional electricity generated from additional coal mined as a result of this rule is not, in reality, perfectly offset by decreased demand for electricity from natural gas and other sources, the net greenhouse gas emissions of the proposed action are likely higher than the Forest Service estimates.

VI. The Forest Service Must Reconsider Whether the Benefits of this Deregulatory Action Justify the Significant Social Costs, under Executive Order 12,866 and NEPA

In the *Federal Register* notice to reinstate this exception to the Colorado Roadless Rule, the Forest Service concludes that "USDA consulted with the Office of Management and Budget and determined this proposed rule does not meet the criteria for a significant regulatory action under Executive Order 12,866."[80] That determination is questionable, but it also does not excuse the Forest Service from the responsibility of explaining why the benefits of this deregulatory action justify its significant social costs. According to the agency's own statements, the rule might not be justified.

This exception to the Roadless Rule qualifies as a significant regulatory action under Executive Order 12,866. By its own terms, the Roadless Rule exception is a "notice of proposed rulemaking,"[81]

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[78] IPCC Working Group I, Fifth Assessment Report, Climate Change 2013: The Physical Science Basis, Chapter 8: Anthropogenic and Natural Radiative Forcing (2014) at 633, 711-712, 714 (Table 8.7), available at https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf (see the adjustment identified in note B for fossil methane).

[79] SDEIS at 96, n.3.

[80] 80 Fed. Reg. at 72,668.

[81] 80 Fed. Reg. at 72,665.

and so clearly meets the definition of a "regulatory action" under Executive Order 12,866.[82] A "significant" regulatory action includes actions "likely to result in . . . an annual effect on the economy of $100 million or more or adversely effect in a material way . . . the environment."[83] The monetary threshold considers both a rule's gross costs and benefits, whether costs result from compliance with new regulation or are social costs of deregulation.[84] With up to $13.7 billion in total discounted social costs and up to $2.4 billion in total discounted benefits, as well as considerable unquantified social costs and $639 million annually in alleged distributional effects,[85] the rule very well might surpass the monetary threshold for "significance." And with the additional generation of up to 131 million tons of carbon dioxide emissions, plus additional methane emissions with a combined global warming potential equivalent to 26 million tons of carbon dioxide,[86] the rule is responsible for generating as much greenhouse gas emissions as EPA's proposed methane standards for the oil and gas industry (a "significant" rule) will mitigate over a 20-year period (at 7.7 million tons of carbon dioxide equivalents per year).[87] This deregulatory action's adverse effects on the environment certainly should qualify it as "significant."

Ultimately, it is up to individual agencies and OIRA/OMB to determine a rule's significance and whether it is subject to the Executive Order's requirements for a formal cost-benefit analysis. But most of the Executive Order applies to all regulations, not just significant ones. In particular, for all regulations, the Executive Order mandates that "Each agency shall assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs."[88]

When focusing on the global perspective (the only defensible perspective) and throwing out the 10th percentile Social Cost of Carbon estimate (an indefensible value), the present net monetized value of either alternative action will be negative under all scenarios—all the more true when significant, currently unmonetized costs, such as from methane emissions, are also subtracted from the sum.[89] The Forest Service acknowledges that, from the global perspective, "no-action might be the preferred alternative."[90] Furthermore, in its sensitivity analysis, the Forest Service found that when monetizing methane on the basis of carbon dioxide-equivalent values, even the present net value of the national and forest-only analyses are negative or close to $0.[91] Given the agency's own calculations, the Forest Service may be hard pressed to explain why the private benefits of this deregulatory action justify the substantial social costs, under the principles of Executive Order 12,866.

Similarly, the aim of NEPA is to inform the decision whether to proceed with an action and to help decisionmakers identify steps to mitigate adverse effects. CEQ instructs that "agencies should consider reasonable mitigation measures and alternatives," and specifically lists carbon capture

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[82] Exec. Order No. 12,866 § 3(d), 58 Fed. Reg. 51735 (Sept. 30, 1993).

[83] *Id.* § 3(f).

[84] Policy Integrity, *Fixing Regulatory Review* 16 (2008), http://policyintegrity.org/files/publications/FixingRegulatoryReview.pdf.

[85] SDEIS at table 3-21, table 3-17.

[86] SDEIS at table 3-20 (total net change in methane emissions for the B-average scenario). Using the 20-year global warming potential values for methane, rather than the 100-year values, methane emissions would be 77 million.

[87] EPA, *Proposed Climate, Air Quality, and Permitting Rules for the Oil and Natural Gas Industry: Fact Sheet*, http://www3.epa.gov/airquality/oilandgas/pdfs/og_fs_081815.pdf.

[88] Exec. Order No. 12,866 § 1(b)(6).

[89] *See* SDEIS at table 3-22 (focusing on global boundary's central and lower estimates of net present value).

[90] *Id.* at 100.

[91] *Id.* at E-25.

and beneficial use of fugitive methane as potential measures.[92] Given that the deregulatory action's social costs outweigh its benefits, and given that the Forest Service has declined to study potential mitigation measures such as methane capture and carbon offsets,[93] the Forest Service should reconsider whether it has fulfilled its mandate under NEPA.

VII. The Social Cost of Carbon and Social Cost of Methane, While Appropriate for Current Use, Should Be Refined through Ongoing Updates

The Environmental Defense Fund, the Institute for Policy Integrity at New York University School of Law, the Natural Resources Defense Council, and the Union of Concerned Scientist have previously submitted joint comments to multiple agencies on the use of the Social Cost of Carbon and Methane. Those comments affirm that the values are sufficiently robust and accurate to continue to be the basis for regulatory analysis going forward. Yet as economic and scientific research continues to develop in the future, the values should be revised, and our comments offer recommendations for that future revision. Those recommendations (from a previous set of comments submitted to EPA) have been appended to this set of comments to the Forest Service.

Sincerely,

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* No part of this document purports to present New York University School of Law's views, if any.

[92] CEQ, *Draft Guidance for Greenhouse Gas Emissions, supra* note 2, at 20.

[93] SDEIS at 9.

Appendix: Joint Comments on the Social Cost of Carbon and Social Cost of Methane, including Recommendations for Refinement, Submitted Previously to EPA

December 4, 2015

Environmental Protection Agency

Attn: Docket ID No. EPA-HQ-OAR-2010-0505,
Oil and Natural Gas Sector: Emission Standards for New and Modified Sources

Comments submitted by: Environmental Defense Fund, Institute for Policy Integrity at New York University School of Law, Natural Resources Defense Council, and Union of Concerned Scientists.

Our organizations respectfully submit these comments regarding EPA's valuation of the benefits of its performance standards the oil and gas sector—specifically, the use of the Social Cost of Methane methodology developed by Marten et al. Our organizations may separately and independently submit other comments regarding the proposed standards themselves.

We strongly affirm that the Social Cost of Methane approach is methodologically sound and should be applied to value methane emissions. As demonstrated below, if anything, current values are significant underestimates the Social Cost of Methane.

Our comments are summarized in six sections. Because the Social Cost of Methane methodology draws on and is similar to the Interagency Working Group's development of the Social Cost of Carbon (SCC) values, we begin by affirming that the SCC estimates are sufficiently robust and accurate to continue to be the basis for regulatory analysis going forward. As economic and scientific research continues to develop in the future, the values should be revised, and we offer recommendations for that future revision. Then we move to support and recommend refinements specific to the Social Cost of Methane. Finally, we close with recommendations for the use of these values in regulatory impact analyses.

1. Introduction: The SCC is an important policy tool.

2. The Interagency Working Group's (IWG) analytic process was science-based, open, and transparent.

3. The SCC is an important and accepted tool for regulatory policy-making, based on well-established law and fundamental economics.

4. Recommendations on further refinements to the SCC.

5. Support for the Social Cost of Methane methodology, and recommendations on refinements.

6. Conclusion: Recommendations on the use of the SCC and Social Cost of Methane in regulatory impact analyses.

1. Introduction: The SCC is an important policy tool.

The SCC estimates the economic cost of climate impacts—specifically the additional economic harm caused by one additional metric ton of carbon dioxide (CO_2) emissions. SCC calculations are important for evaluating the costs of activities that produce greenhouse gas emissions and contribute to climate change, such as burning fossil fuels to produce energy. The SCC is also important for evaluating the benefits of policies that would reduce the amount of those emissions going into the atmosphere. For example, in order to properly evaluate standards that reduce the use of carbon-intensive energy, improve energy efficiency, or lead to the capture and beneficial use of greenhouse gases—like the proposed rule—it is important to understand the benefits they will provide, including the benefit of reducing carbon pollution and the harm it causes.

As with all economic impact analyses, the exercise can only provide a partial accounting of the costs of climate change (those most easily monetized) and inevitably involves incorporating elements of uncertainty. However, accounting for the economic harms caused by climate change is a critical component of sound benefit-cost analyses of regulations that directly or indirectly limit greenhouse gases. This endeavor is important because benefit-cost analysis is a central tool of regulatory policy in the United States, first institutionalized in a 1981 executive order by President Ronald Reagan. The executive order currently in effect provides that agencies:

- "[P]ropose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); . . .
- "[S]elect, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); . . .
- "In applying these principles, each agency is directed to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. Where appropriate and permitted by law, each agency may consider (and discuss qualitatively) values that are difficult or impossible to quantify, including equity, human dignity, fairness, and distributive impacts."[94]

Benefit-cost analysis has long been a staple of agency rulemakings, usually conducted as part of the regulatory impact analysis associated with proposed rules. Even though the analysis is generally not able to encompass all of the effects of a policy, and it is challenging to translate impacts on health, mortality, and welfare into dollar values, benefit-cost analysis is an important economic tool to help inform decision-makers about the societal benefits of different policy choices. Of course, benefit-cost analysis cannot be the sole criterion for making regulatory decisions, especially in cases where there are overriding public health, equity, or safety imperatives.[95] And in a few instances, legal protections prohibit the consideration of benefit-cost analysis.

Without an SCC estimate, regulators would by default be using a value of zero for the benefits of reducing carbon pollution, implying that carbon pollution has no costs. That, sadly, is not the case, as evidenced by the large body of research outlining the sobering health, environmental, and economic impacts of rising temperatures, extreme weather, intensifying smog, and other climate impacts. If anything, most evidence points to the fact that current numbers significantly underestimate the SCC. It would be arbitrary for a federal agency to weigh the societal benefits and costs of a rule with significant carbon pollution effects but to assign no value at all to the considerable benefits of reducing carbon pollution.[96]

2. The IWG's analytic process was science-based, open, and transparent.

To facilitate accounting for the costs of climate impacts and the benefits of reducing carbon pollution in regulatory proceedings undertaken by different agencies, the United States government

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[94] Exec. Order No. 13,563 §§ 1(b)-(c), 76 Fed. Reg. 3,821 (Jan. 18, 2011); *see also infra* on how this and subsequent orders, including Exec. Order No. 13,609, inform the use of a global SCC value.

[95] President Clinton issued Executive Order 12,866 in 1993, establishing new guidance for benefit-cost analysis and explicitly directing agencies to consider, in addition to costs and benefits for which quantitative estimates are possible, "qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider." Exec. Order No. 12,866 § 1(a), 58 Fed. Reg. 51,735 (Sept. 30, 1993).

[96] Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1199 (9th Cir. 2008) (holding unlawful NHTSA's fuel economy standards for passenger vehicles when NHTSA ascribed a value of "zero" to the benefits of mitigating carbon dioxide, reasoning that "NHTSA assigned no value to *the most significant benefit* of more stringent CAFE standards: reduction in carbon emissions" (emphasis added)).

assembled an Interagency Working Group (IWG) to develop an estimate of a social cost of carbon that can be utilized in rulemakings and other pertinent settings across the federal government.[97] The IWG's estimates—first released in 2010 and updated in 2013 and 2015—have been used in numerous benefit-cost analyses related to federal rulemakings.[98] The IWG recently released an updated set of SCC estimates, centered at approximately $40 per metric ton of CO_2 for emissions in the year 2015, in 2015 dollars at a 3% discount rate.[99] The 2015 SCC estimates are higher than those from 2010, reflecting the growing understanding of the costs that climate impacts will impose on society.

The increase in the SCC estimate is important because it reflects the growing scientific and economic research on the risks and costs of climate change, but is still very likely an underestimate of the economic cost of carbon emissions. The increase also reflects the costs of climate change that we are already experiencing, such as those associated with sea level rise and rising temperatures. Climate change is making coastal flooding, drought, and impacts from extreme weather worse. A rapidly increasing body of evidence has linked ever more recent events directly to climate change.[100]

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[97] The IWG involved a large number of agencies, including the Council of Economic Advisers, Council on Environmental Quality, Department of Agriculture, Department of Commerce, Department of Transportation, Environmental Protection Agency, National Economic Council, Office of Energy and Climate Change, Office of Management and Budget, Office of Science and Technology Policy, and the Department of the Treasury. *See* INTERAGENCY WORKING GROUP ON THE SOCIAL COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12,866 (2010) [hereinafter "2010 TSD"], *available at* http://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf.

[98] The SCC has been used in numerous notice-and-comment rulemakings by various agencies since it was published in 2010, and each of these occasions has provided opportunity for public comment on the SCC. *See, e.g.*, Energy Conservation Program: Energy Conservation Standards for Residential Clothes Washers, 77 Fed. Reg. 32,381 (May 31, 2012); Energy Conservation Program: Energy Conservation Standards for Residential Dishwashers, 77 Fed. Reg. 31,964 (May 30, 2012); Energy Conservation Program: Energy Conservation for Battery Chargers and External Power Supplies, 77 Fed. Reg. 18,478 (Mar. 27, 2012); Energy Conservation Program: Energy Conservation Standards for Standby Mode and Off Mode for Microwave Ovens, 77 Fed. Reg. 8526 (Feb. 14, 2012); Energy Conservation Program: Energy Conservation Standards for Distribution Transformers, 77 Fed. Reg. 7282 (Feb. 10, 2012); Energy Conservation Program for Certain Industrial Equipment: Energy Conservation Standards and Test Procedures for Commercial Heating, Air-Conditioning, and Water-Heating Equipment, 77 Fed. Reg. 2356 (Jan. 17, 2012); 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 76 Fed. Reg. 74,854 (Dec. 1, 2011); Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews, 76 Fed. Reg. 52,738 (Aug. 23, 2011); Energy Conservation Program: Energy Conservation Standards for Residential Furnaces and Residential Central Air Conditioners and Heat Pumps, 76 Fed. Reg. 37,549 (June 27, 2011); Energy Conservation Program: Energy Conservation Standards for Residential Clothes Dryers and Room Air Conditioners, 76 Fed. Reg. 22,324 (Apr. 21, 2011); Energy Conservation Program: Energy Conservation Standards for Fluorescent Lamp Ballasts, 76 Fed. Reg. 20,090 (Apr. 11, 2011); National Emission Standards for Hazardous Air Pollutants: Mercury Emissions from Mercury Cell Chlor-Alkali Plants, 76 Fed. Reg. 13,852 (Mar. 14, 2011); Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, 75 Fed. Reg. 74,152 (Nov. 30, 2010); Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Sewage Sludge Incineration Units, 75 Fed. Reg. 63,260 (Oct. 14, 2010); Energy Conservation Program: Energy Conservation Standards for Residential Refrigerators, Refrigerator-Freezers, and Freezers, 75 Fed. Reg. 59,470 (Sept. 27, 2010); Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 75 Fed. Reg. 45,210 (Aug. 2, 2010). The undersigned organizations have provided comment on the SCC in a number of these proceedings.

[99] 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 12,866 (2015); *see also* 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 12,866 (2013) [hereinafter "2013 TSD"], *available at* http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf.

[100] *See generally* Thomas C. Peterson et al. eds., *Explaining Extreme Events of 2012 from a Climate Perspective*, 94 BULL. AMER. METEOR. SOC. S1-74 (2013), and IPCC, *Special Report: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (2012). On the scientific research connecting weather and other climate-related events to

The analytic work of the IWG has been transparent. The 2010 Technical Support Document (TSD) set out in detail the IWG's decision-making process with respect to how it assessed and employed the models.[101] Furthermore, the Government Accountability Office (GAO) found that "the working group's processes and methods reflected the following three principles: *Used consensus-based decision making, Relied on existing academic literature and models, and Took steps to disclose limitations and incorporate new information."*[102]

Because the 2013 IWG made no changes to the input assumptions and procedures for deriving its SCC estimates, the 2013 TSD discussed only how the three Integrated Assessment Models (IAMs) used in the analysis were updated in the academic literature over the three-year interim period by the independent researchers who have developed these models. The 2013 TSD also established that the increase in the SCC estimate from 2010 to 2013 resulted solely from updates to the three underlying IAMs.[103]

The 2015 TSD update provided detailed responses[104] to public comments collected through an opportunity for public participation initiated by the Office of Management and Budget (OMB).[105] Additionally, the comment period on these proposed standards are yet another opportunity for continued dialogue about areas requiring further study. Such repeated comment processes and updates demonstrate that the IWG's SCC estimates were developed—and are being used—transparently. Given the strong grounding in the best science available, nothing should prevent the current, continued use of this well-established estimate. As economic and scientific research continues to develop, future revisions will be able to further refine existing estimates based on the latest peer-reviewed literature and the latest updates to the quality of the overall modeling exercise.

3. The SCC is an important and accepted tool for regulatory policy-making based on well-established law and fundamental economics.

The legal and analytic basis for using the SCC is clear and well established. ***As a matter of law and economics, uncertainty in benefits estimates does not mean they should be excluded from regulatory impact analyses***. No benefit or cost estimates are certain. Further, the courts have explicitly rejected the argument that uncertainty in assessing the costs of climate impacts provided a basis for ignoring them in assessing the benefits and costs of regulations, and executive orders dating back as far as the Reagan administration have all issued guidelines specifying explicit consideration of benefits even if the precise size of the benefit is uncertain.

In 2008, the U.S. Court of Appeals for the Ninth Circuit determined that agencies could not assign a zero dollar value to the social costs of the impacts of climate change. It determined that *failing* to count SCC benefits would be illegal. In this case, the National Highway Traffic Safety Administration (NHTSA) had decided not to count any avoided climate damages in issuing fuel economy standards. The court concluded: "NHTSA's reasoning is arbitrary and capricious for several reasons. First

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climate change, see Peter A. Stott et al., "Attribution of Weather and Climate-Related Events." In *Climate Science for Serving Society*, edited by Ghassem R. Asrar and James W. Hurrell. Netherlands: Springer s307-37 (2013).

[101] *See generally* 2010 TSD, *supra* note 97.

[102] GAO, REGULATORY IMPACT ANALYSIS: Development of Social Cost of Carbon Estimates, GAO-14-663 (2014).

[103] The 2010 and 2013 IWGs did very little to adjust the three IAMs. The main adjustment by IWG was to DICE to ensure that the IAM had an exogenous growth path that matched FUND and PAGE for the purposes of modeling various socio-economic and emission scenarios. *Id.* at 24.

[104] OMB & Interagency Working Group, Response to Comments on Social Cost of Carbon (July 2015).

[105] OMB, Notice of Availability and Request for Comments, Technical Support Documents: Social Cost of Carbon for Regulatory Impact Analysis, 78 Fed. Reg. 70,586 (Nov. 26, 2013).

while the record shows that there is a ***range of values***, the value of carbon emission reductions is certainly ***not zero*** (emphasis added)."[106]

Like the Court of Appeals, executive orders dating back to 1981 have also required agencies to assess benefits and costs even when significant uncertainty exists. Every president since (and including) Ronald Reagan has issued directives requiring that agencies conduct cost-benefit analyses of proposed regulations where permitted by statute.[107] Specifically, agencies are directed to "take into account benefits and costs, both quantitative and qualitative . . . and use the ***best available techniques*** to quantify anticipated present and future benefits and costs as accurately as possible."[108] The IWG's use of Integrated Assessment Models (IAMs) reflects the best available, peer-reviewed science to tally the benefits and costs of specific regulations with impacts on carbon dioxide emissions. While we address ways for improvement in the next section, current IAMs include benefits and costs that have been quantified to date.

The bottom line is that the IWG has properly and lawfully used the best available techniques to quantify the benefits of carbon emission reductions, basing its analysis on the peer-reviewed literature. When agencies use the IWG's estimates of the SCC to calculate the benefits of a rulemaking, they have taken, and will continue to take, comment on the SCC and the process used to derive that value. That is what the law—and good policy—requires.

The IWG Correctly Used a Global SCC Value.

To design the economically efficient policies necessary to forestall severe and potentially catastrophic climate change, all countries must use a global SCC value. Given that the United States and many other significant players in the international climate negotiations have already applied a global SCC framework in evaluating their own climate policies, the continued use of the global value in U.S. regulatory decisions may be strategically important as the United States seeks to set an example for other countries, harmonize regulatory systems, and take the lead in ongoing international negotiations. Binding legal obligations, basic ethical responsibilities, and practical considerations further counsel in favor of the United States using a global SCC value.

To avoid a global "tragedy of the commons" and an economically inefficient degradation of the world's climate resources, all countries should set policy according to a global SCC value. The climate and clean air are global common resources, meaning they are free and available to all countries, but any one country's use—i.e., pollution—imposes harms on the polluting country as well as the rest of the world. Because greenhouse gases do not stay within geographic borders but rather mix in the atmosphere and affect climate worldwide, each ton of carbon pollution emitted by the United States not only creates domestic harms, but also imposes additional and large externalities on the rest of the world, including disproportionate harms to some of the least-developed nations. Conversely, each ton of carbon pollution abated in another country will benefit the United States along with the rest of the world.

If all countries set their greenhouse gas emission levels based on only their domestic costs and benefits, ignoring the large global externalities, the collective result would be substantially sub-optimal climate protections and significantly increased risks of severe harms to all nations, including to the United States. "[E]ach pursuing [only its] own best interest . . . in a commons brings

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[106] Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1200 (9th Cir. 2008) (emphases added).

[107] Stuart Shapiro, *The Evolution of Cost-Benefit Analysis in U.S. Regulatory Decisionmaking*, *in* HANDBOOK ON THE POLITICS OF REGULATION 385-392 (David Levi-Faur ed., 2011).

[108] Exec. Order No. 13,563 §§ 1(a)-(c), 76 Fed. Reg. 3,821 (Jan. 18, 2011) (emphasis added).

ruin to all."[109] By contrast, a global SCC value would require each country to account for the full damages of its greenhouse gas pollution and so to collectively select the efficient level of worldwide emissions reductions needed to secure the planet's common climate resources.

Thus, well-established economic principles demonstrate that the United States stands to benefit greatly if all countries apply a global SCC value in their regulatory decisions. A rational tactical option in the effort to secure that economically efficient outcome is for the United States to continue using a global SCC value itself. The United States is engaged in a repeated strategic game of international negotiations and regulatory coordination, in which several significant players—including the United States—have already adopted a global SCC framework.[110] For the United States to now depart from this implicit collaborative dynamic by reverting to a domestic-only SCC estimate could undermine the country's long-term interests in future climate negotiations and could jeopardize emissions reductions underway in other countries, which are already benefiting the United States.[111] A domestic-only SCC value could be construed as a signal that the United States does not recognize or care about the effects of its policy choices on other countries, and signal that it would be acceptable for other countries to ignore the harms they cause the United States. Further, a sudden about-face could undermine the United States' credibility in negotiations. The United States has recently reasserted its desire to take a lead in both bilateral and international climate negotiations.[112] To set an example for the rest of the world, to advance its own long-term climate interests, and to secure greater cooperation toward reducing global emissions, strategic factors support the continued use a global SCC value in U.S. regulatory decisions.

Though the Constitution balances the delegation of foreign affairs power between the executive and legislative branches, "[t]he key to presidential leadership is the negotiation function. Everyone agrees that the President has the exclusive power of official communication with foreign governments."[113] The development and analysis of U.S. climate regulations are essential parts of the dialogue between the United States and foreign countries about climate change. Using a global SCC value communicates a strong signal that the United States wishes to engage in reciprocal actions to mitigate the global threat of climate change. The President is responsible for developing and executing the negotiation strategy to achieve the United States' long-term climate interests. Currently, the President has instructed federal agencies to use a global SCC value as one important step that encourages other countries to take reciprocal actions that also account for global externalities. The President's constitutional powers to negotiate international agreements would be seriously impaired if federal agencies were forced to stop relying on a global SCC value.[114]

In fact, the United States has already begun to harmonize with other countries its policies on climate change and on the valuation of regulatory benefits. The recent U.S.-China agreement is but the latest example. For instance, the United States has entered into a joint Regulatory Cooperation

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[109] Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968).

[110] *See infra* notes 68 and 125 to 128, and accompanying text, detailing use of a global SCC value by Canada, Mexico, the United Kingdom, France, Germany, and Norway.

[111] *See* ROBERT AXELROD, THE EVOLUTION OF COOPERATION 10-11 (1984) (on repeated prisoner's dilemma games).

[112] EXEC. OFFICE OF THE PRES., THE PRESIDENT'S CLIMATE ACTION PLAN 17-21 (2013).

[113] Phillip R. Trimble, *The President's Foreign Affairs Power*, 83 AM. J. OF INTL. L. 750, 755 (1989).

[114] *See* David Remnick, *The Obama Tapes*, NEW YORKER, Jan. 23, 2014, *available at* http://www.newyorker.com/online/blogs/newsdesk/2014/01/the-obama-tapes.html (quoting interview with President Obama: "[M]y goal has been to make sure that the United States can genuinely assert leadership in this issue internationally, that we are considered part of the solution rather than part of the problem. And if we are at the table in that conversation with some credibility, then it gives us the opportunity to challenge and engage the Chinese and the Indians, as long as we take into account the fact that they've still got, between the two of them, over a billion people in dire poverty. . . . This is why I'm putting a big priority on our carbon action plan here. It's not because I'm ignorant of the fact that these emerging countries are going to be a bigger problem than us. It's because it's very hard for me to get in that conversation if we're making no effort.").

Council with Canada, which has adopted a work plan that commits the two countries to synchronizing "aggressive" greenhouse gas reductions, especially in the transportation sector.[115] A separate Regulatory Cooperation Council with Mexico calls generally for improving and harmonizing policy "by strengthening the analytic basis of regulations,"[116] and its work plan acknowledges the transboundary nature of environmental risks.[117] Mexico and Canada have both adopted greenhouse gas standards for vehicles that harmonize with the U.S. standards[118] and that calculate benefits according to a global SCC value.[119] Canada has also used the IWG's global SCC value in developing carbon dioxide standards for its coal-fired power plants, estimating $5.6 billion (Canadian dollars) worth of global climate benefits.[120] The direct U.S. share of the net benefits from that Canadian regulation will likely total in the hundreds of millions of dollars.[121]

Further efforts at regulatory harmonization are currently underway. For example, the United States is now negotiating a Transatlantic Trade and Investment Partnership with the European Union, and a key element is regulatory coordination.[122] The European Union has already adopted an Emissions Trading Scheme (ETS) to cap its greenhouse gas emissions, and its Aviation Directive is just one of the climate policies that could be shaped by these negotiations.[123] The European Commission has indicated its willingness to further reduce its ETS cap if other major emitters make proportional commitments[124]—a result that will only occur if countries consider more than their own domestic costs and benefits from reducing greenhouse gas emissions. Moreover, several individual European

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[115] UNITED STATES-CANADA REGULATORY COOPERATION COUNCIL, JOINT ACTION PLAN, at 16 (2011), *available at* http://www.whitehouse.gov/sites/default/files/omb/oira/irc/us-canada_rcc_joint_action_plan.pdf.

[116] UNITED STATES-MEXICO HIGH-LEVEL REGULATORY COOPERATION COUNCIL, WORK PLAN at 3 (2012), *available at* http://www.whitehouse.gov/sites/default/files/omb/oira/irc/united-states-mexico-high-level-regulatory-cooperation-council-work-plan.pdf.

[117] *Id.* at 11 (noting that oil drilling activities in the Gulf of Mexico conducted by either country "present risks for both countries, and both countries would benefit from a common set of drilling standards").

[118] *See* INT'L COUNCIL ON CLEAN TRANSP., MEXICO LIGHT-DUTY VEHICLE CO_2 AND FUEL ECONOMY STANDARDS 4 (Policy Update, July 2013), *available at* http://www.theicct.org/sites/default/files/publications/ICCTupdate_Mexico_LDVstandards_july2013.pdf (noting that Mexico's standards were based on the U.S. and Canadian standards).

[119] *See* Heavy-Duty Vehicle and Engine Greenhouse Gas Emission Regulations, SOR/2013-24, 147 Can. Gazette pt. II, 450, 544 (Can.), *available at* http://canadagazette.gc.ca/rp-pr/p2/2013/2013-03-13/html/sor-dors24-eng.html ("The SCC is used in the modelling of the cost-benefit analysis . . . . It represents an estimate of the economic value of avoided climate change damages *at the global level*. . . . The values used by Environment Canada are based on the extensive work of the U.S. Interagency Working Group on the Social Cost of Carbon.") (emphasis added); Instituto Nacional de Ecología, Mexico, Regulatory Impact Analysis on *PROY-NOM-163- SEMARNAT-ENER-SCFI-2012, Emisiones de bióxido de carbono (CO_2) provenientes del escape y su equivalencia en términos de rendimiento de combustible, aplicable a vehículos automotores nuevos de peso bruto vehicular de hasta 3857 kilogramos* (July 5, 2012), *available at* http://207.248.177.30/mir/formatos/defaultView.aspx?SubmitID=273026 ("[S]e obtienen beneficios ambientales por la reducción del consumo de combustible, los cuales se reflejan en beneficios a la salud de la población en el caso de contaminantes criterio, y en *beneficios globales para las emisiones evitadas de CO_2*.") (emphasis added).

[120] 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.

[121] $5.6 billion in Canadian dollars is worth $5.0 billion in U.S. dollars (using February 2014 conversion rates). Seven to twenty-three percent of $5 billion is between $350 million and $1.15 billion. *See* 2010 TSD, *supra* note 97, at 11 (provisionally calculating the direct U.S. share of a global SCC value at between 7-23%, though ultimately recommending "that using the global (rather than domestic) value . . . is the appropriate approach," for reasons consistent with these comments).

[122] *See* EUR. COMM'N, TRANSATLANTIC TRADE AND INVESTMENT PARTNERSHIP: THE REGULATORY PART (2013).

[123] *See* SIERRA CLUB, THE TRANSATLANTIC FREE TRADE AGREEMENT: WHAT'S AT STAKE FOR COMMUNITIES AND THE ENVIRONMENT at 9-10 (2013).

[124] Eur. Comm'n, Working with International Partners, http://www.e.europa.eu/clima/policies/international ("The EU is offering to step up its 2020 reduction targets to 30% if other major economies commit.").

nations—including the United Kingdom,[125] France,[126] Germany,[127] and Norway[128]—have adopted a global SCC value for use in their regulatory analyses. Some other European countries, such as Sweden, have adopted carbon taxes that implicitly operate as a high SCC that accounts for global externalities.[129]

As further evidence of how the United States' use of a global SCC value is already influencing other international actors to follow suit, the International Monetary Fund (IMF) applies in its policy reviews an SCC estimate based on the IWG number.[130] Given the potential influence of the IMF on the environmental policies of developing countries,[131] the pull that the IWG's global estimate has at the IMF could be very advantageous to the United States, by motivating industrializing countries to use similar numbers in the future.

In addition to this compelling strategic argument—namely, that it is rational for the United States and other countries to continue their reciprocal use of a global SCC value to achieve the economically efficient outcome on climate change (and avoid catastrophic climate impacts)—legal obligations further prescribe using a global SCC value. A basic ethical responsibility to prevent transboundary environmental harms has been enshrined in customary international law.[132] For the United States to knowingly set pollution levels in light of only domestic harms, willfully ignoring that its pollution directly imposes environmental risks—including catastrophic risks—on other countries, would violate norms of comity among countries. The United States would be knowingly causing foreseeable harm to other countries, without compensation or just cause. Given that the nations most at risk from climate change are often the poorest countries in the world, such a policy would also violate basic and widely shared ethical beliefs about fairness and distributive justice.

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[125] ECONOMICS GROUP, DEFRA, U.K., THE SOCIAL COST OF CARBON AND THE SHADOW PRICE OF CARBON: WHAT THEY ARE, AND HOW TO USE THEM IN ECONOMIC APPRAISAL IN THE UK 1 (2007); *see also* Ministry of Finance, Norway, Cost-Benefit Analysis: Carbon Price Paths, *available at* http://www.regjeringen.no/en/dep/fin/Documents-and-publications/official-norwegian-reports-/2012/nou-2012-16-2/10.html?id=713585 ("The United Kingdom has changed its method for the valuation of greenhouse gas emissions. Prior to 2009, the estimated global social cost of carbon was used, but one [sic] has now switched over to pricing in line with the necessary marginal cost of meeting long-term domestic emission reduction targets in conformity with the EU Climate and Energy Package.").

[126] *See* Balázs Égert, *France's Environmental Policies: Internalising Global and Local Externalities* 8-10 (OECD Economics Department Working Papers No. 859, 2011), *available at* http://dx.doi.org/10.1787/5kgdpn0n9d8v-en (discussing global impacts and France's history of calculating the SCC); Oskar Lecuyer & Philippe Quirion, funded by the European Union's Seventh Framework Programme, *Choosing Efficient Combinations of Policy Instruments for Low-Carbon Development and Innovation to Achieve Europe's 2050 Climate Targets—Country Report: France* at 8 (2013) (noting the prospects for a carbon tax in 2014-15, and explaining that "A 2009 stakeholder and expert group led by the 'Conseil d'analyse stratégique' (a public body in charge of expertise and stakeholder dialogue) set the optimal level of the carbon tax (the social cost of carbon) at € 32/tCO 2 in 2010, and rising to € 100 in 2030 and € 200 in 2050.").

[127] Testimony of Howard Shelanski, OIRA Admin., before the H. Comm. on Oversight & Gov't Reform's Subcomm. on Energy Policy, Healthcare, and Entitlements, July 18, 2013, at 3 (explaining that the global SCC value estimated by the IWG is consistent with values used by Germany and the United Kingdom).

[128] *See* Ministry of Finance, *supra* note 125 (explaining that, for projects not already covered by a binding emission limitation, the carbon price should "be based on the marginal social cost of carbon," meaning "the global cost of emitting one additional tonne of CO_2e"). Note that Norway has joined the E.U.'s trading scheme.

[129] Henrik Hammar, Thomas Sterner & S. Åkerfeldt, *Sweden's CO_2 Tax and Taxation Reform Experiences*, in REDUCING INEQUALITIES: A SUSTAINABLE DEVELOPMENT CHALLENGE (Genevey, R. et al. eds., 2013).

[130] *E.g.*, Benedict Clements et al., International Monetary Fund, *Energy Subsidy Reforms: Lessons and Implications* 9 (IMF Policy Paper, Jan. 28, 2013).

[131] *See* Natsu Taylor Saito, *Decolonization, Development, and Denial*, 6 FL. A & M U. L. REV. 1, 16 (2010) (quoting former IMF counsel as saying "today it is common to find these institutions [IMF and World Bank] requiring their borrowing member countries to accept and adhere to prescribed policies on environmental protection").

[132] *See* PHILIPPE SANDS, PRINCIPLES OF INTERNATIONAL ENVIRONMENTAL LAW 241 (2d ed. 2003) (noting that "the responsibility not to cause damage to the environment of other states or of areas beyond national jurisdiction has been accepted as an obligation by all states[;] . . . there can be no questions but that Principle 21 [of the Stockholm Declaration on the Human Environment] reflects a rule of customary international law").

Indeed, taking a global approach to measuring climate benefits is consistent with the ideals of transboundary responsibility and justice that the United States commits to in other foreign affairs.[133]

Binding international agreements also require consideration and mitigation of transboundary environmental harms. Notably, the United Nations Framework Convention on Climate Change—to which the United States is a party—declares that countries' "policies and measures to deal with climate change should be cost-effective so as to ensure *global benefits* at the lowest possible cost."[134] The Convention further commits parties to evaluating global climate effects in their policy decisions, by "employ[ing] appropriate methods, for example *impact assessments* . . . with a view to minimizing adverse effects on the economy, on public health and on the quality of the environment, of projects or measures undertaken by them to mitigate or adapt to climate change."[135] The unmistakable implication of the Convention is that parties—including the United States—must account for global economic, public health, and environmental effects in their impact assessments.

Similar obligations exist in domestic U.S. law as well. For example, the U.S. National Environmental Policy Act recognizes "the worldwide and long-range character of environmental problems"[136] and requires federal agencies to include reasonably foreseeable transboundary effects in their environmental impact statements.[137] While some individual statutes under which federal agencies will craft climate policies may be silent on the issue of considering extraterritorial benefits, arguably the most important statute for U.S. climate policy—the Clean Air Act—requires the control of air emissions that affect other countries and so encourages a global assessment of greenhouse gas effects. Specifically, Section 115 of the Clean Air Act directs EPA and the states to mitigate U.S. emissions that endanger foreign health and welfare.[138] The global perspective on climate costs and benefits required by that provision should inform all regulatory actions developed under the Clean Air Act, and may provide useful guidance under other statutes as well.[139]

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[133] *See* Paul Baer & Ambuj Sagar, *Ethics, Rights and Responsibilities*, in CLIMATE CHANGE SCIENCE AND POLICY (Stephen Schneider et al., eds., 2009).

[134] United Nations Framework Convention on Climate Change, May 9, 1992, S. Treat Doc. No. 102-38, 1771 U.N.T.S. 107, Article 3(3) (emphasis added); *see also id.* at Article 3(1) ("The Parties should protect the climate system for the *benefit of present and future generations of humankind*, on the basis of *equity* and in accordance with their common but *differentiated responsibilities* and respective capabilities.") (emphasis added); *id.* at Article 4(2)(a) (committing developed countries to adopt policies that account for "the need for equitable and appropriate contributions by each of these Parties to the global effort").

[135] *Id.* at Article 4(1)(f) (emphasis added); *see also id.* at Article 3(2) (requiring parties to give "full consideration" to those developing countries "particularly vulnerable to the adverse effects of climate change"). *See also* North American Agreement on Environmental Cooperation (1993), 32 I.L.M. 1480, art. 10(7) (committing the United States to the development of principles for transboundary environmental impact assessments).

[136] 42 U.S.C. § 4332(2)(F).

[137] COUNCIL ON ENVIRONMENTAL QUALITY, GUIDANCE ON NEPA ANALYSIS FOR TRANSBOUNDARY IMPACTS (1997), *available at* http://www.gc.noaa.gov/documents/transguide.pdf; *see also* CEQ, DRAFT NEPA GUIDANCE ON CONSIDERATION OF THE EFFECTS OF CLIMATE CHANGE AND GREENHOUSE GAS EMISSIONS at 2 (2010), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ceq/20100218-nepa-consideration-effects-ghg-draft-guidance.pdf (defining climate change as a "global problem"); *see also* Exec. Order No. 12,114, *Environmental Effects Abroad of Major Federal Actions*, 44 Fed. Reg. 1957 §§ 1-1, 2-1 (Jan. 4, 1979) (applying to "major Federal actions . . . having significant effects on the environment outside the geographical borders of the United States," and enabling agency officials "to be informed of pertinent environmental considerations and to take such considerations into account . . . in making decisions regarding such actions").

[138] 42 U.S.C. § 7415.

[139] For details on the applicability of Section 115, see Petition from the Institute for Policy Integrity, to EPA, for Rulemakings and Call for Information under Section 115, Title VI, Section 111, and Title II of the Clean Air Act to Regulate Greenhouse Gas Emissions (Feb. 19, 2013); *see also* Nathan Richardson, *EPA and Global Carbon: Unnecessary Risk*, COMMON RESOURCES, Feb. 28, 2013 (explaining how Section 115 authorizes use of a global SCC value when regulating under other Clean Air Act provisions).

Presidential orders on regulatory analysis also support use of a global SCC value. In 2012, President Obama issued Executive Order 13,609 on promoting international regulatory cooperation.[140] The Order built on his previous Executive Order 13,563, which in turn had affirmed its 1993 predecessor, Executive Order 12,866, in requiring benefit-cost analysis of significant federal regulations.[141] Though White House guidance published in 2003 on regulatory impact analysis under E.O. 12,866 assumed that most analyses would focus on domestic costs and benefits, it ultimately deferred to the discretion of regulatory agencies on whether to evaluate "effects beyond the borders of the United States."[142] More importantly, since the publication of that guidance, President Obama has issued his own supplemental orders on regulatory analysis, including E.O. 13,609, which clarified the importance of international cooperation to achieve U.S. regulatory goals. This 2012 order explicitly recognizes that significant regulations can have "significant international impacts,"[143] and it calls on federal agencies to work toward "best practices for international regulatory cooperation with respect to regulatory development."[144] By employing a global SCC value in U.S. regulatory development, and by encouraging other countries to follow that best practice and account for the significant international impacts of their own climate policies, federal agencies will advance the mission of this presidential order on regulatory harmonization.

Finally, two practical considerations counsel in favor of a global SCC value. First, unlike some other significant international environmental impacts, no methodological limitations block the quantitative estimation of a global SCC value. In recent regulatory impact analyses for major environmental rules, EPA has qualitatively considered important transnational impacts that could not be quantified. For example, in the Mercury and Air Toxics Standards, EPA concluded that a reduction of mercury emissions from U.S. power plants would generate health benefits for foreign consumers of fish, both from U.S. exports and from fish sourced in foreign countries. EPA did not quantify these foreign health benefits, however, due to complexities in the scientific modeling.[145] Similarly, in the analysis of the Cross-State Air Pollution Rule, EPA noted—though could not quantify—the "substantial health and environmental benefits that are likely to occur for Canadians" as U.S. states reduce their emissions of particulate matter and ozone—pollutants that can drift long distances across geographic borders.[146] Yet where foreign costs or benefits are important and

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[140] 77 Fed. Reg. 26,413 (May 4, 2012).

[141] *Id.* § 1 (explaining the order intends to "promot[e] the goals of Executive Order 13563"); *see also* Exec. Order No. 13,563, *Improving Regulation and Regulatory Review*, § 1(b), 76 Fed. Reg. 3821 (Jan. 18, 2011) (reaffirming Exec. Order No. 12,866, 58 Fed. Reg. 51,741 (Sept. 30, 1993) and requiring benefit-cost analysis).

[142] OMB, CIRCULAR A-4, at 15 (2003). In sharp contrast to the Circular's ultimate deferral to agencies on the issue of considering transboundary efficiency effects, the Circular makes very clear that international transfers and distributional effects should be assessed as costs and benefits to the United States: "Benefit and cost estimates should reflect real resource use. Transfer payments are monetary payments from one group to another that do not affect total resources available to society. . . . However, transfers from the United States to other nations *should* be included as costs, and transfers from other nations to the United States as benefits, as long as the analysis is conducted from the United States perspective." *Id.* at 38 (emphasis original). In other words, even if federal agencies use a global SCC value to assess efficiency effects relating to their climate policies, that global valuation will not prevent the agencies from also counting international transfers or distributional effects that benefit the United States as benefits. *See* Comments from the Institute for Policy Integrity, to EPA, on Proposed Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards, at 12-13 (Nov. 27, 2009) (explaining that, depending on the relevant statutory mandate, agencies may calculate a monopsony benefit to the United States even while using a global SCC value).

[143] 77 Fed. Reg. at 26,414, § 3(b).

[144] 77 Fed. Reg. at 26,413, § 2(a)(ii)(B) (defining the goals of the regulatory working group).

[145] EPA, REGULATORY IMPACT ANALYSIS FOR THE FINAL MERCURY AND AIR TOXICS STANDARDS at 65 (2011) ("Reductions in domestic fish tissue concentrations can also impact the health of foreign consumers . . . [and] reductions in U.S. power plant emissions will result in a lowering of the global burden of elemental mercury . . . .").

[146] Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 75 Fed. Reg. 45,209, 45,351 (Aug. 2, 2010).

quantifiable, other federal agencies frequently include those calculations.[147] Given that sophisticated models already exist to quantify the global SCC, the global estimate is appropriate to use.

Second, a global SCC value is in the national interest because harms experienced by other countries could significantly impact the United States. Climate damages in one country could generate large spillover effects to which the United States is especially vulnerable. The mesh of the global economy is woven tightly, and disruptions in one place can have consequences around the world. As seen historically, economic disruptions in one country can cause financial crises that reverberate globally at a breakneck pace.[148] In a similar vein, national security analysts in government and academia increasingly emphasize that the geopolitical instability associated with climatic disruptions abroad poses a serious threat to the United States.[149] Due to its unique place among countries—both as the largest global economy with trade- and investment-dependent links throughout the world, and as a military superpower—the United States is particularly vulnerable to international spillover effects.

The 2010 TSD included a rigorous examination of global versus domestic SCC estimates.[150] Consistent with the above discussion, the 2010 IWG reached the conclusion to estimate a global SCC value, citing both the global impacts of climate change and the global action needed to mitigate climate change. The IWG restated these arguments in the 2013 TSD, and refers back explicitly to its discussion in the 2010 TSD.[151] EPA should continue using a global SCC estimate in its regulatory impact analyses.

4. Recommendations on further refinements to the SCC.[152]

The IWG process uses assumptions that accord with economic and scientific theory. Economic models, and the scientific analyses they draw from, are of course improving continuously. Future updates to the SCC should build on these and go further. As further refinements better account for climate change impacts not yet incorporated into the modeling, all indications are that the estimated benefits of curbing carbon pollution will rise substantially over current estimates.

The IWG appropriately used consumption discount rates rather than returns on capital.

With respect to the **discount rate**, the IWG conducted sensitivity analysis of the results to three constant consumption discount rates: 2.5%, 3%, and 5%; for each of the discount rates, the TSDs reported the various moments and percentiles[153] of the SCC estimates.

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[147] *E.g.*, Unique Device Identification System, 78 Fed. Reg. 58,786 (Sept. 24, 2013) ("[I]n our final regulatory impact analysis we include an estimate of the costs to foreign labelers."); Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption, 78 Fed. Reg. 3504 (Jan. 16, 2013) (including costs to foreign farms); U.S. Customs and Border Protection Regulatory Agenda, RIN 1651-AA96 Definition of Form I-94 to Include Electronic Format (2013) (preliminarily estimating net benefits to foreign travelers and carriers).

[148] Steven L. Schwarz, *Systemic Risk*, 97 GEO. L.J. 193, 249 (2008) (observing that financial collapse in one country is inevitably felt beyond that country's borders).

[149] *See, e.g.*, Department of Defense, Climate Change Adaptation Roadmap (2014); CNA Military Board, National Security and the Accelerating Risks of Climate Change (2014).

[150] 2010 TSD, *supra* note 97, at 10-11.

[151] 2013 TSD, *supra* note 99, at 14-15.

[152] The following section relies heavily on Richard L. Revesz et al., *Global Warming: Improve Economic Models of Climate Change*, 508 NATURE 173 (2014), on Gernot Wagner & Martin L. Weitzman, *Climate Shock*, Princeton University Press (2015), on Frank J. Convery & Gernot Wagner, *Reflections—Managing Uncertain Climates: Some Guidance for Policy Makers and Researchers* (forthcoming in REVIEW OF ENVIRONMENTAL ECONOMICS AND POLICY) as well as on several papers cited in footnotes throughout.

The discount rate is one of the most important inputs in models of climate damages, with plausible assumptions easily leading to differences of an order of magnitude in the SCC. The climate impacts of present emissions will unfold over hundreds of years. When used over very long periods of time, discounting penalizes future generations heavily due to compounding effects. For example, at a rate of 1%, $1 million 300 years hence equals over $50,000 today; at 5% it equals less than 50 cents.[154] The discount rate changed by a factor of five, whereas the discounted value changed by more than five orders of magnitude. Depending on the link between climate risk and economic growth risk, even a rate of 1% may be too high.[155] Uncertainty around the correct discount rate pushes the rate lower still.[156]

The IWG correctly excluded a 7% discount rate, a typical private sector rate of return on capital, for several reasons. First, typical financial decisions, such as how much to save in a bank account or invest in stocks, focus on private decisions and utilize private rates of return. Private market participants typically have short time horizons. However, here we are concerned with social discount rates because emissions mitigation is a public good, where individual emissions choices affect public well-being broadly. Rather than evaluating an optimal outcome from the narrow perspective of investors alone, economic theory would require that we make the optimal choices based on societal preferences (and social discount rates). Second, climate change is expected to affect primarily consumption, not traditional capital investments.[157] OMB guidelines note that in this circumstance, consumption discount rates are appropriate.[158] Third, 7% is considered much too high for reasons of discount rate uncertainty and intergenerational concerns (further discussed below).

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[153] The moments of a distribution (of SCC estimates in this case) are, loosely speaking, the various values that describe the distribution's shape: what value is the distribution centered around (mean); how wide is the distribution (the variance); whether the distribution is lopsided (skewness); and whether it is tall and skinny or short and fat (kurtosis). A percentile is a statistical measure of the value (the SCC value in this case) below which a specified percentage of (SCC) observations falls. The 1st percentile indicates the SCC value above which (the other) 99% of observed SCC values fall. The 99th percentile indicates the SCC value below which 99% of all observed SCC values fall.

[154] Dallas Burtraw & Thomas Sterner, *Climate Change Abatement: Not "Stern" Enough?* (Resources for the Future Policy Commentary Series, Apr. 4, 2009), *available at* http://www.rff.org/Publications/WPC/Pages/09_04_06_Climate_Change_Abatement.aspx.

[155] "If climate risk dominates economic growth risk because there are enough potential scenarios with catastrophic damages, then the appropriate discount rate for emissions investments is lower tha[n] the risk-free rate and the current price of carbon dioxide emissions should be higher. In those scenarios, the "beta" of climate risk is a large negative value and emissions mitigation investments provide insurance benefits. If, on the other hand, growth risk is always dominant because catastrophic damages are essentially impossible and minor climate damages are more likely to occur when growth is strong, times are good, and marginal utility is low, then the "beta" of climate risk is positive, the discount rate should be higher than the risk-free rate, and the price of carbon dioxide emissions should be lower." Robert B. Litterman, *What Is the Right Price for Carbon Emissions?,* REGULATION, Summer 2013, at 38, 41, *available at* http://www.cato.org/sites/cato.org/files/serials/files/regulation/2013/6/regulation-v36n2-1-1.pdf

[156] See following subsection.

[157] "There are two rationales for discounting future benefits—one based on consumption and the other on investment. The consumption rate of discount reflects the rate at which society is willing to trade consumption in the future for consumption today. Basically, we discount the consumption of future generations because we assume future generations will be wealthier than we are and that the utility people receive from consumption declines as their level of consumption increases . . . . The investment approach says that, as long as the rate of return to investment is positive, we need to invest less than a dollar today to obtain a dollar of benefits in the future. Under the investment approach, the discount rate is the rate of return on investment. If there were no distortions or inefficiencies in markets, the consumption rate of discount would equal the rate of return on investment. There are, however, many reasons why the two may differ. As a result, using a consumption rather than investment approach will often lead to very different discount rates." Maureen Cropper, *How Should Benefits and Costs Be Discounted in an Intergenerational Context?*, 183 RESOURCES 30, 33.

[158] *See* CIRCULAR A-4, *supra* note 142, at 33.

The IWG correctly adopted as one of its discount rates a value reflecting long-term interest rate uncertainty, and—as a primary extension to current results—should go further by directly implementing a declining discount rate.

The IWG was correct in choosing as one of its discount rates an estimate based upon declining discount rates (2.5%). Since the IWG undertook its initial analysis, 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. Arrow *et al* (2013) presents several arguments that strongly support the use of declining discount rates for long-term benefit-cost analysis.[159]

Perhaps the best reason is the simple fact that there is considerable uncertainty around which interest rate to use: uncertainty in the rate points directly to the need to use a declining rate, as the impact of the uncertainty grows exponentially over time. The uncertainty about future discount rates could stem from a number of reasons particularly salient to climate damages, including uncertainties in future economic growth, consumption, and the interest rate reaped by investments.

A possible declining interest rate schedule for consideration by the IWG is the one proposed by Weitzman (2001).[160] It is derived from a broad survey of top economists and the profession at large in a climate change context and explicitly incorporates arguments around interest rate uncertainty. Arrow *et al* (2013, 2014), Cropper *et al* (2014), and Gollier and Weitzman (2010), among others, similarly argue for a declining interest rate schedule and lay out the fundamental logic.[161]

Moreover, the United States would not be alone in using a declining discount rate. It is standard practice for the United Kingdom and French governments, among others.[162] The U.K. schedule explicitly subtracts out an estimated time preference.[163] France's schedule is roughly similar to the United Kingdom's. Importantly, all of these discount rate schedules yield lower present values than the constant 2.5% Newell-Pizer rate, suggesting that even the lowest discount rate evaluated by the IWG is too high.[164] The consensus of leading economists is that a declining discount rate schedule should be used, consistent with the approach of other countries like the United Kingdom. Adopting

[159] The arguments here are primarily based on: 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?*, REV ENVIRON ECON POLICY 8 (2014); Richard G. Newell & William A. Pizer, *Discounting the Distant Future: How Much Do Uncertain Rates Increase Valuations?,* 46 J. ENVTL. ECON. & MGMT. 52 (2003); Maureen L. Cropper et al., *Declining Discount Rates*, AMERICAN ECONOMIC REVIEW: PAPERS AND PROCEEDINGS (2014); S.K. Rose, D. Turner, G. Blanford, J. Bistline, F. de la Chesnaye, and T. Wilson. *Understanding the Social Cost of Carbon: A Technical Assessment.* EPRI Report #3002004657 (2014).

[160] Martin L. Weitzman, *Gamma Discounting*, 91 AM. ECON. REV. 260, 270 (2001). Weitzman's schedule is as follows:

1-5 years	6-25 years	26-75 years	76-300 years	300+ years
4%	3%	2%	1%	0%

[161] Arrow et al. (2013, 2014), Cropper et al. (2014), *supra* note 159. Christian Gollier & Martin L. Weitzman, *How Should the Distant Future Be Discounted When Discount Rates Are Uncertain?* 107 ECONOMICS LETTERS 3 (2010).

[162] *Id*.

[163] Joseph Lowe, H.M. Treasury, U.K., Intergenerational Wealth Transfers and Social Discounting: Supplementary Green Book Guidance 5 (2008), *available at* http://www.hm-treasury.gov.uk/d/4(5).pdf. The U.K. declining discount rate schedule that subtracts out a time preference value is as follows:

0-30 years	31-75 years	76-125 years	126-200 years	201-300 years	301+ years
3.00%	2.57%	2.14%	1.71%	1.29%	0.86%

[164] Using the IWG's 2010 SCC model, Johnson and Hope find that the U.K. and Weitzman schedules yield SCCs of $55 and $175 per ton of CO_2, respectively, compared to $35 at a 2.5% discount rate. Laurie T. Johnson & Chris Hope, *The Social Cost of Carbon in U.S. Regulatory Impact Analyses: An Introduction and Critique*, 2 J. ENVTL. STUD. & SCI. 205, 214 (2012).

such a schedule would increase the SCC substantially from the administration's central estimate, suggesting that even the high end of the range presented by the administration is likely too low.

The IWG's choice of three IAMs was fully justified but should still be revisited in its next iteration.

In its calculations of the SCC, the IWG relied on the three Integrated Assessment Models (IAMs) available at the time, all with a long record of peer-reviewed publications that link physical and economic effects: the Dynamic Integrated Model of Climate and the Economy (DICE),[165] the Climate Framework for Uncertainty, Negotiation, and Distribution (FUND),[166] and Policy Analysis of the Greenhouse Effect (PAGE).[167] The government's first SCC estimates, published in 2010, used the then-current versions of the models; the recent update employed revised, peer-reviewed versions of the models but maintained the underlying assumptions of the 2010 IWG analysis. As stated by the 2010 IWG, "the main objective of [the 2010 IWG modeling] process was to develop a range of SCC values using a defensible set of input assumptions grounded in the existing scientific and economic literatures."[168]

DICE, FUND, and PAGE are well-established, peer-reviewed models. They represent the state-of-the-art IAMs. Each of these models has been developed over decades of research, and has been subject to rigorous peer review, documented in the published literature. However, updates to the SCC should also consider other models that are similarly peer reviewed and based on the state of the art of climate-economic modeling. One such model is Climate and Regional Economics of Development (CRED); another is the World Bank's ENVironmental Impact and Sustainability Applied General Equilibrium (ENVISAGE) model.

CRED borrows its fundamental structure from William Nordhaus's DICE and RICE models but also offers significant changes. For one, it uses updated damage functions and Marginal Abatement Cost Curves (MACC). Moreover, it uses different global equity weights, and uses additional state-of-the-art methodologies.[169]

ENVISAGE represents a broader modeling effort by the World Bank, where perhaps the largest contribution is a more detailed sectoral breakdown, using 57 different sectors.[170] This level of analysis allows for a more detailed view of agriculture as well as food and energy sectors that are particularly important to any climate-economy modeling.

Moreover, the broader policy and research community at large ought to consider creating the right incentive structure within the economic and scientific community to engage many more researchers on working with the core IAMs. Doing so could speed up the process of capturing the latest research on climate damages.

No model fully captures the costs of climate impacts to society. In fact, virtually all uncertainties and current omissions point to a higher SCC value. That makes it essential to use the established IWG process, which provides for updating the SCC estimates every two to three years in order to capture

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[165] William D. Nordhaus, *Estimates of the social cost of carbon: concepts and results from the DICE-2013R model and alternative approaches*, 1 JOURNAL OF THE ASSOCIATION OF ENVIRONMENTAL AND RESOURCE ECONOMISTS 1 (2014).

[166] David Anthoff & Richard S.J. Tol, THE CLIMATE FRAMEWORK FOR UNCERTAINTY, NEGOTIATION AND DISTRIBUTION (FUND), TECHNICAL DESCRIPTION, VERSION 3.6 (2012), *available at* http://www.fund-model.org/versions.

[167] Chris Hope, *The Marginal Impact of CO_2 from PAGE2002: An Integrated Assessment Model Incorporating the IPCC's Five Reasons for Concern*, 6 INTEGRATED ASSESSMENT J. 19 (2006).

[168] 2010 TSD, *supra* note 97, at 1.

[169] Frank Ackerman, Elizabeth A. Stanton & Ramón Bueno, *CRED: A New Model of Climate and Development*, 85 ECOLOGICAL ECONOMICS 166 (2013).

[170] World Bank, ENVISAGE, http://go.worldbank.org/8DTXIDMRM0 (last visited Feb. 4, 2014).

the advances in physical and social sciences that have been incorporated into the models during the intervening period, in order to revisit both the choice of models and the key inputs used.[171]

The IWG should update its socio-economic assumptions to reflect the latest Shared Socio-economic Pathways (SSPs).

One key input is the use of socio-economic scenarios reflected in the choice of economic growth rates and emissions trajectories. Current IWG socio-economic and emissions scenarios were chosen from the Stanford Energy Modeling Forum exercise, EMF-22, and consist of projections for income/consumption, population, and emissions (CO_2 and non-CO_2). The IWG selected five sets of trajectories, four of which represent business as usual (BAU) trajectories (MiniCAM, MESSAGE, IMAGE, and MERGE models) and a fifth that represents a CO_2 emissions pathway with CO_2 concentrations stabilizing at 550 ppm. Given the possibility of increases in emissions above those expressed by Business As Usual Scenarios, a high-CO_2 emissions pathway should also be considered. The assumptions used in calculating the SCC should be updated regularly to reflect the latest thinking around possible scenarios, reflecting the latest Shared Socio-economic Pathways (SSPs).[172] These SSPs represent the latest, consistent pathways, feeding, for example, into the latest IPCC report.

The current inclusion of CO_2 fertilization benefits likely overstates its effects.

The models do not reflect recent research on agricultural changes, which suggest the CO_2 fertilization is overestimated, particularly in the FUND model, and that much, if not all, of the fertilization benefits may be cancelled out by negative impacts on agriculture (e.g., extreme heat, pests, and weeds).[173] If the agency is not able to adequately model all agricultural impacts it should, at a minimum, remove CO_2 fertilization benefits.

The specific functional form assumptions in IAMs ought to be re-evaluated.

Climate damages in IAMs are assumed to affect levels of economic output rather than economic growth rates. Similarly, standard modeling assumptions assume multiplicative damage functions—i.e. substitutability across economic sectors—rather than additive functions—i.e. limited substitutability across sectors. IAMs ought to probe the impacts of both assumptions. Recent literature supports the conclusion that climate change will effect economic growth rates.[174]

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[171] 2010 TSD, *supra* note 97, at 1-3 ("The estimates are presented with an acknowledgement of the many uncertainties involved and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts . . . . Specifically, we have set a preliminary goal of revisiting the SCC values within two years or at such time as substantially updated models become available, and to continue to support research in this area.").

[172] Kristie L. Ebi et al., *A New Scenario Framework for Climate Change Research: Background, Process, and Future Directions*, 122 CLIMATIC CHANGE 363, 368 (2014).

[173] FRANK ACKERMAN & ELIZABETH A. STANTON, CLIMATE ECONOMICS: THE STATE OF THE ART 45-56 (2013); Wolfram Schlenker et al., *Will U.S. Agriculture Really Benefit From Global Warming? Accounting for Irrigation in the Hedonic Approach*, 95 AM. ECON. REV. 395, 395-406 (2005). See also: Fisher, Anthony C., W. Michael Hanemann, Michael J. Roberts, and Wolfram Schlenker. 2012. "The Economic Impacts of Climate Change: Evidence from Agricultural Output and Random Fluctuations in Weather: Comment." *American Economic Review*, 102(7): 3749-60. **DOI:** 10.1257/aer.102.7.3749

[174] *See* Melissa Dell et al., *Temperature shocks and economic growth: Evidence from the last half centur*y, 4 AMERICAN ECONOMIC JOURNAL: MACROECONOMICS 66-95 (2012); R. Bansal & M. Ochoa *Temperature, aggregate risk, and expected returns* (National Bureau of Economic Research No. w17575, 2011); E.J. Moyer et al., *Climate impacts on economic growth as drivers of uncertainty in the social cost of carbon* (University of Chicago Coase-Sandor Institute for Law & Economics Research Paper 652, 2013); S. Dietz & N. Stern, *Endogenous Growth, Convexity of Damage and Climate Risk: How Nordhaus' Framework Supports Deep Cuts in Carbon Emissions*, 125 THE ECONOMIC JOURNAL 574-620 (2015); F.C. Moore & D.B. Diaz *Temperature impacts on economic growth warrant stringent mitigation policy*, NATURE CLIMATE CHANGE (2015).

Marshall Burke et al., *Global Non-Linear Effect of Temperature on Economic Production*, NATURE (Oct. 21, 2015) looks at the effect of temperature and precipitation changes on economic growth rates, and finds that a 23% decline in global GDP by 2100 for business as usual. This is much higher than previous macro-estimates by Dell et al., *supra*, is more

Similarly, models ought to better capture the impacts of wildly heterogeneous climate damages. Each of the models used to calculate the SCC assume one representative household, going as far as to consider damages by relatively large regions. Such averaging ignores the enormously diverse effects of damages. It similarly contributes to not fully capturing the effects of extreme outcomes and tail risks. Instead, models ought to attempt to capture a much broader array of damages and climate impacts.[175]

The IWG used solid economic tools to address uncertainty and ought to go further in capturing the full extent of its implications.

The IWG was rigorous in addressing **uncertainty**. First, it conducted Monte Carlo simulations over the IAMs specifying different possible outcomes for climate sensitivity (represented by a Roe and Baker Distribution).[176] It also used five different emissions growth scenarios and three discount rates. Second, the IWG reported the various moments and percentiles[177] of the resulting SCC estimates. Third, the IWG put in place an updating process, e.g., the 2013 revision, which updates the models as new information becomes available.[178] As such, the IWG used the various tools that economists have developed over time to address the uncertainty inherent in estimating the economic cost of pollution: reporting various measures of uncertainty, using Monte Carlo simulations, and updating estimates as evolving research advances our knowledge of climate change.

The Monte Carlo framework took a step toward addressing what is the most concerning aspect of climate change, the potential for **catastrophic damages**, i.e., low probability/high damage events. These damages come from: uncertainty in the underlying parameters in IAMs,[179] including the climate sensitivity parameter; climate tipping points[180]—thresholds that, when crossed, cause rapid, often irreversible changes in ecosystem characteristics; and "black swan" events—which refer to unknown unknowns.[181]

The analysis used a right-skewed distribution of temperature (as captured in the Roe Baker climate sensitivity parameter) and an increasing, strictly convex damage function;[182] this correctly results in right-skewed distributions of damage and SCC estimates. By using the mean values of these estimates instead of the median, IWG estimates partially captured the effects of small probability,

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consistent with previous micro-estimates, and challenges assumptions that climate change will not affect the growth rates of wealthy nations.

[175] See, for example, National Science Foundation-funded work by Per Krusell and Anthony A. Smith on "A Global Economy-Climate Model with High Regional Resolution" using 19,000 agents (each covering a 1 x 1° area of land).

[176] *See infra* note 188.

[177] *See supra* note 153.

[178] The federal government has committed to continuing to update SCC estimates to account for new information. The IWG stated in its 2010 TSD that "[i]t is important to emphasize that the interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. Specifically, we have set a preliminary goal of revisiting the SCC values within two years or at such time as substantially updated models become available, and to continue to support research in this area. In the meantime, we will continue to explore the issues raised in this document and consider public comments as part of the ongoing interagency process." 2010 TSD, *supra* note 97, at 3.

[179] In this case, parameters are the various characteristic that describe the underlying climate and economic systems.

[180] *See generally* Timothy M. Lenton et al., *Tipping Elements in the Earth's Climate System*, 105 PNAS 1786 (2008).

[181] Standard decision theory under uncertainty addresses "known unknowns," which are unknowns for which we can specify a probability distribution function. In the cases of "unknown unknowns," i.e., 'black swan' events, we cannot specify a probability distribution function, raising a host of additional questions. *See*, *e.g.*, Richard J. Zeckhauser, *Investing in the Unknown and Unknowable*, CAPITALISM & SOCIETY vol. 1, iss. 2, art. 5 (2006).

[182] An increasing, strictly convex climate damage function implies a damage function that is strictly increasing in temperature at an increasing rate.

higher damages from high-level warming events.[183] To reflect uncertainty in estimates resulting from the right-skewed distribution of SCC estimates, the IWG reported the SCC value for the 95th percentile from the central 3% discount rate distribution.[184] This is done to reflect the estimation uncertainty in terms of the possibility of higher-than-expected economic impacts from climate change.

While the IAMs take different approaches to explicitly modeling tipping points, which to a great extent is lacking in current versions of FUND and DICE, the IWG improved (but in no way fixed) the representation of uncertain catastrophic damages with the Monte Carlo analysis. Still, black swan events go completely unaddressed in the IWG modeling framework, and therefore the SCC estimates do not reflect the value of preventing the occurrence of catastrophic events.[185]

In addition to choosing an appropriate discount rate and sensitivity analyses around different SSPs, another important parameter to which the SCC estimates are sensitive is Equilibrium Climate Sensitivity (ECS)—how the climate system responds to a constant radiative forcing, which is typically expressed as the temperature response to a doubling of CO_2 concentration in the atmosphere.[186] In its current iteration, the IWG conducted extensive sensitivity analyses over a range of equilibrium climate sensitivity estimates.[187] The assumptions are clearly stated in the TSD. In addition to its sensitivity analysis, the IWG conducted a Monte Carlo simulation over the climate sensitivity parameter and the other random variables specified within the three IAMs.[188]

The range for the Equilibrium Climate Sensitivity (ECS) is derived from a combination of methods that constrain the values from measurements in addition to models. These include measured ranges from paleoclimate records, observed comparisons with current climate, as well as responses to recent climate forcings. The currently agreed "likely" range for the ECS (from both the IPCC TAR

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[183] The point here is that we miss the big picture if we ignore the "tails" (the upper-most values in the case of the right-skewed SCC), and as a result come to the wrong conclusions. An everyday analogy is airplane safety regulation: safety is protected by guarding against the low-probability but highly dangerous events. With climate change we do not have the luxury of knowing with certainty how damaging the extremes could be or whether they will be triggered by greenhouse gases accumulating in the atmosphere; all we know is that there is a very real possibility they could occur and could be devastating.

[184] This approach partially captures catastrophic damages via tipping points through the PAGE model.

[185] *See, e.g.*, Peter Howard, *Omitted Damages: What's Missing from the Social Cost of Carbon* (Cost of Carbon Project Report, 2014), and van den Bergh, J. C. J. M., and W. J. W. Botzen, *A lower bound to the social cost of CO_2 emissions*, 4 NATURE CLIMATE CHANGE 4 (2014).

[186] *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS—SUMMARY FOR POLICYMAKERS 14 (2013).

[187] Specifying the climate sensitivity parameter as a random variable has a basis in PAGE02, which species a probability distribution function for the parameter. The IWG calibrated the Roe and Baker distribution, a right-skewed distribution, to characterize the probability distribution function of this parameter. The 2010 TSD explains the IWG's choice of the Roe and Baker distribution. The right-skewed nature of the climate sensitivity parameter's probability distribution function is independent of the IWG's choice of the Roe and Baker distribution. Rather, this skewness results from the IPCC's finding that values of the climate sensitivity parameter above 4.5 degree Celsius cannot be excluded. As a result, all of the probability distribution functions fit by the IWG for the climate sensitivity parameter were skewed to the right (see Figure 2 in the 2010 TSD), including Roe and Baker. *See* 2010 TSD, *supra* note 97, at 14, fig. 2.

[188] A Monte Carlo simulation will run an integrated assessment model thousands of times, each time randomly picking the value of uncertain parameters from a probability distribution function, i.e. a function that assigns a probability to each possible parameter value. In the case of the SCC, the IWG ran 10,000 Monte Carlo simulations for each of the three IAMs and five socio-economic scenarios, randomizing the value of climate sensitivity, i.e., the change in average global temperature associated with a doubling of CO_2, and all other uncertain parameters in the IAMs by the original authors. For each randomly drawn set of values, the IAM estimated the associated damages, with the final SCC estimate equaling the average value across all 10,000 runs, five socio-economic scenarios, and then across all three models. Therefore, each SCC estimate is calculated using 150,000 runs.

and AR5) is 1.5-4.5 degrees Celsius. Physical constraints make it "extremely unlikely" that the ECS is less than 1 degree Celsius and "very unlikely" greater than 6 degrees Celsius.[189]

A host of analyses points to the costs of such uncertainty—both for values that go outside the "likely" range and for uncertainty within it: in short, the optimal SCC tends to increase with increased uncertainty, sometimes dramatically so.[190] While the current treatment of uncertainty around climate sensitivity by the IWG highlights a range of possible uncertainties, a reconsideration of the assumptions feeding into the SCC ought to take the latest advances highlighting the potentially higher costs of deep-seated uncertainty into account. Additionally, the IWG should consider whether it relies too heavily on its 95th percentile estimates as a catchall to cover for limitations in its treatment of uncertainty and catastrophic damages.

5. Support for the Social Cost of Methane methodology, and recommendations on continued improvements.

EPA anticipates that its oil and gas standards will reduce significant amounts of methane. On the other hand, the regulation will slightly accelerate the production of some carbon dioxide, as methane is flared and immediately releases carbon dioxide, versus a more gradual oxidation into carbon dioxide of methane otherwise un-flared and emitted.[191] EPA proposes directly estimating the Social Cost of Methane using an analysis conducted by Marten *et al.*, which is based on the same techniques the Interagency Working Group developed to estimate the SCC.[192] The Marten *et al.* Social Cost of Methane methodology is well supported, and in the final emissions standards, EPA should monetize the benefits of methane reductions, to reflect the true benefits of the standards and to enhance the rigor and defensibility of the final rule.[193] EPA also calls for comments on whether it should apply SCC estimates to measure the small disbenefit from the accelerate release of carbon dioxide; it should.

The Interagency Working Group on the Social Cost of Carbon has, to date, focused exclusively on carbon dioxide. The SCC can be roughly adjusted to approximate the costs of other greenhouse gases by multiplying by the relative global warming potential of those gases. Scientists, however, have long argued that the full social costs of specific, non-carbon dioxide gases like methane should be assessed through separate models and methodologies, which would more accurately account for varying atmospheric life spans, among other differences.[194] At least a dozen published studies, dating back to 1993, have estimated the social cost of non-carbon dioxide greenhouse gases, including methane.[195]

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[189] IPCC, *supra* note 186, at 14.

[190] *E.g.,* Robert S. Pindyck, *Uncertain Outcomes and Climate Change Policy*, 63 J. ENVTL. ECON. & MGMT. 289 (2012); Martin L. Weitzman, *GHG Targets as Insurance Against Catastrophic Climate Damages*, 14 J. PUB. ECON. THEORY 221 (2012); Robert S. Pindyck, *The Climate Policy Dilemma*, 7 REV. ENVTL. ECON. & POL'Y 219 (2013); Gernot Wagner & Richard J. Zeckhauser, *Confronting Deep Uncertainty on Climate Sensitivity: When Good News is Bad News*, ('Beyond IPCC' Presentation, October 17, 2014).

[191] 80 Fed. Reg. 56,657.

[192] Marten, A.L., E.A. Kopits, C.W. Griffiths, S.C. Newbold & A. Wolverton (2014). Incremental CH4 and N2O Mitigation Benefits Consistent with the U.S. Government's SC-CO2 Estimates, Climate Policy, DOI: 10.1080/14693062.2014.912981.

[193] *See Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin.,* 538 F.3d 1172, 1202 (9th Cir. 2008) (finding NHTSA's decision to assign zero value to carbon reductions to be arbitrary and capricious).

[194] *See* Disa Thureson & Chris Hope, *Is Weitzman Right? The Social Cost of Greenhouse Gases in an IAM World* 21 (Örebro University-Swedish Business School Working Paper 3/2012).

[195] *See, e.g.*, Marten et al., *supra* note 98, at 7 (describing eleven prior studies estimating the social cost or global damage potential associated with methane).

EPA proposes to use Social Cost of Methane estimates based on one of the most recent peer-reviewed articles: Marten *et al*.[196] Marten *et al.* takes a reasonable (although conservative) approach to estimating the Social Cost of Methane and currently constitutes "the best available science" to inform agency regulation.[197] Specifically, Marten *et al*. builds on the methodology used by the Interagency Working Group to develop the SCC. The study maintains the same three integrated assessment models, five socioeconomic-emissions scenarios, equilibrium climate sensitivity distribution, three constant discount rates, and aggregation approach that were agreed upon by the Interagency Working Group. Consequently, many of the key assumptions underlying the Social Cost of Methane estimates have already gone through a transparent, consensus-driven, publically reviewed, regularly updated process, since they were borrowed from the Interagency Working Group's thoroughly vetted methodology.

Yet while sharing that carefully built framework with the SCC estimates, Marten *et al*.'s Social Cost of Methane estimates directly account for the quicker time horizon of methane's effects compared to carbon dioxide, include the indirect effects of methane on radiative forcing,[198] and reflect the complex, nonlinear linkages along the pathway from methane emissions to monetized damages. Marten *et al*. was not only published in a peer reviewed economics journal, but EPA undertook additional internal and peer review of the approach.[199] Marten *et al*.'s estimates thus are reasonable and appropriate measurements of the Social Cost of Methane.

In fact, Marten *et al.*'s estimates are conservative and very likely underestimate the true Social Cost of Methane. To start, as the authors note, because their methodology followed the Interagency Working Group's approach, all limitations that apply to inputs and modelling assumptions for the SCC also apply to the Social Cost of Methane. As discussed above, omitted damages, socio-economic assumptions, the treatment of uncertainty and catastrophic damages, and so forth all suggest the Social Cost of Methane is underestimated, just as the SCC is.

Additionally, the integrated assessment models shared by both the Social Cost of Methane and the SCC include some features better suited to assessing carbon dioxide effects than methane effects, and so likely underestimate the costs of methane. For example, a countervailing benefit of carbon dioxide emissions—enhanced fertilization in the agricultural sector—is included in the underlying models used to develop both the SCC and Social Cost of Methane, yet does not apply to methane emissions.[200] Similarly, the damage functions used by the integrated assessment models assume

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[196] Alex L. Marten et al., *Incremental CH4 and N2O Mitigation Benefits Consistent With the US Government's SC-CO2 Estimates,* Climate Policy (2014).

[197] *See* Executive Order 13,563, 76 Fed. Reg. 3821 (January 18, 2011).

[198] However, the Social Cost of Methane methodology does not yet fully reflect the effects of methane oxidizing in the atmosphere over time and becoming carbon dioxide. *See* Regulatory Impact Analysis for the Proposed Emission Standards for new and Modified Sources in the Oil and Natural Gas Sector, at 4-37 (2015).

[199] http://www3.epa.gov/climatechange/pdfs/social%20cost%20methane%20white%20paper%20application%20and%20peer%20review.pdf

[200] Interagency Working Group on the Social Cost of Carbon, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis*, 12 (February 2010), available at https://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf ("Impacts other than temperature change also vary across gases in ways that are not captured by GWP. For instance . . . damages from methane emissions are not offset by the positive effect of CO2 fertilization.").

Martin et al (2015) state that "A comparison across models further highlights the importance of CO2 fertilization impacts on the global damage potential. CO2 emissions, and the resulting increase in atmospheric concentration, have the potential to increase yields in the agriculture and forestry sector. This characteristic is not shared by other GHG emissions. Accordingly, the FUND model, which explicitly captures this effect, exerts downward pressure on the SC-CO2 that is not present for the SC-CH4 and SC-N2O, allowing for the possibility of substantially higher global damage potential estimates. The results based on the FUND model presented in this article exhibit this effect; however, the CO2 fertilization effect is not explicitly modelled in DICE and PAGE and therefore they are found to produce lower estimates of the global damage potential. For example, using the 3% discount rate, the global damage potential for CH4 as estimated by FUND

some level of adaptation to climate change over time, but because methane is a much faster-acting climate pollutant than carbon dioxide, there is less opportunity for technological advancement or political progress to adapt to the climate damages imposed by methane emissions. Methane also has indirect but significant effects, via its contribution to surface ozone levels, on global health and agriculture, and such effects need to be included either in the Social Cost of Methane or elsewhere in the cost-benefit analysis, but currently are not.[201]

Overall, the Marten *et al*. methodology provides reasonable, direct estimates that reflect updated evidence and provide consistency with the Government's accepted methodology for estimating the SCC. At the same time, EPA should work toward the future refinement of these Social Cost of Methane estimates. For example, the Social Cost of Methane methodology does not yet fully reflect the effects of methane oxidizing in the atmosphere over time and becoming carbon dioxide.[202] Because the Social Cost of Methane and the SCC share many assumptions and methods, it may make sense for the Interagency Working Group to review and update both metrics. In any case, any future improvements made to the SCC methodology should also be incorporated into and adjusted for the Social Cost of Methane estimates.

In particular, *global* Social Cost of Methane values are appropriate to use in EPA's regulatory impact analyses. The many strategic, economic, and legal grounds that justify use of a global SCC apply with equal force to the Social Cost of Methane. For example, other countries already use a global social cost of methane value.[203] The United States, together with several other countries, has been trying to prioritize global action on methane reductions, because as "a powerful, short-lived greenhouse gas," methane has a greater potential to affect "warming in the near to medium term." [204] And the United States has highlighted its planned actions on methane—including these standards for landfills—in its joint statements on climate with China. [205] To demonstrate the U.S. commitment to reducing methane emissions specifically, and to encourage other countries to follow suit in prioritizing efforts on this powerful and fast-acting pollutant, it is strategically important for the United States to continue valuing the global effects of its methane regulations. Under the Clean Air Act, EPA has clear authority to do so.[206] In its final emission standards for the oil and gas sector, and in its final regulatory impact analysis, EPA should bolster the rationales for the use of a global Social Cost of Methane value, as articulated in the underlying Interagency Working Group Technical Support Documents.

If EPA for some reason declines to follow the Marten *et al*. approach, it could still use the global warming potential adjustment as a less accurate, lower-bound estimate. However, instead of the

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ranges between 58 and 88 depending on the scenario, whereas it ranges from 19 to 28 for DICE and PAGE. As the DICE and PAGE models only consider two natural system impacts, temperature and sea level, if they do implicitly include potential CO2 fertilization benefits, they are included by using the temperature anomaly as a proxy for the increasing atmospheric CO2 concentration. Fertilization benefits would therefore be allowed to falsely accrue to perturbations of other GHG emissions besides CO2. It is not clear the degree to which these models try to incorporate CO2 fertilization effects and therefore the degree to which this issue is of concern."

[201] A study by Sarofim et al. (2015) finds that reductions in surface ozone levels from the mitigation of methane emissions would provide additional global health benefits from avoided cardiopulmonary deaths equal to 60 to 140% of climate benefits identified by Marten. Similarly, Shindell (2014) finds that the impact of methane on agriculture, via changes in surface ozone, are valued at $22 and $27 per ton, for 5% and 3% discounting respectively, in addition to his study's estimates for climate and climate-health related damages.

[202] As discussed above, EPA should use the SCC to estimate the small disbenefit of the accelerated release of carbon dioxide due to flaring versus oxidation.

[203] *E.g.*, Defra, U.K., *Methodological Approaches for Using SCC Estimates in Policy Assessment* at 58 (2005) (reporting the PAGE results for the social cost of methane).

[204] *E.g.*, U.S. Dep't of State, *Joint Statement on Climate Change and the Arctic*, Aug. 31, 2015 (made following the GLACIER conference, at which Canada, Denmark, Finland, Iceland, Norway, Sweden, and Russia were also represented).

[205] White House Press Secretary, *U.S.-China Joint Presidential Statement on Climate Change*, Sept. 25, 2015.

[206] *See supra* on the use of a global SCC number and the role of Clean Air Act § 115.

outdated multiplier of 25 for methane, EPA should utilize the latest global warming potential estimates for methane issued by the IPCC: 85 to 87 times greater than carbon dioxide after 20 years and 30 to 36 times greater than carbon dioxide after 100 years (after making the recommended adjustment for fossil methane).[207] Given the short life of methane, EPA should at least conduct sensitivity analysis over the entire global warming potential range, instead of merely utilizing the lower 100-year timescale range. Again, though, the Social Cost of Methane approach is the more reasonable and preferred way to value this rule's important methane reductions.

6. Conclusion: Recommendations on the use of the SCC and Social Cost of Methane in regulatory impact analyses.

EPA should continue to use the latest IWG estimates of the SCC, and should start using the Social Cost of Methane estimates. The current estimates are biased downwards: more can and should be done to improve the estimates and to ensure, through regular updates, that they reflect the latest science and economics. However, the necessary process of improving the ability of the SCC and Social Cost of Methane to fully reflect the costs of climate impacts to society cannot hold up agency rulemaking efforts. The values provide an important, if conservative, estimate of the costs of climate change and the benefits of reducing carbon pollution. To ignore these costs would be detrimental to human health and well-being and contrary to law and Presidential directives to agencies to evaluate the cost of pollution to society when considering standards to abate that pollution. In the context of agency rulemakings, the SCC and Social Cost of Methane provide the best available means to factor those costs into benefit-cost analyses.

In using the estimates in its regulatory impact analyses, however, EPA should also include a qualitative assessment of all significant climate effects that are not currently quantified in the monetized estimate. The IWG acknowledged its incomplete treatment of both catastrophic and non-catastrophic damages, and instructed agencies that "These caveats . . . are necessary to consider when interpreting and applying the SCC estimates."[208] Those instructions are consistent with Executive Orders on regulatory analysis, which tell agencies to "assess . . . qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider."[209] Before the IWG published its first estimates in 2010, some agencies included a detailed chart of unquantified climate effects in their regulatory impact analyses.[210] However, most recent rulemakings only reference unquantified benefits from non-CO_2 gases and from co-pollutants, and list none of the significant, unquantified climate effects from carbon dioxide.[211] In the final emissions standards, and in the final regulatory impact analysis, EPA should detail all significant, unquantified climate effects, as consistent with administration-wide policy, the IWG's instructions, past agency practices, and best economic practices.

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[207] IPCC Working Group I, Fifth Assessment Report, Climate Change 2013: The Physical Science Basis, Chapter 8: Anthropogenic and Natural Radiative Forcing (2014) at 633, 711-712, 714 (Table 8.7), available at https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf (see the adjustment identified in note B for fossil methane).

[208] 2010 TSD, *supra* note 97, at 29.

[209] Exec. Order No. 12,866 § 1(a); *see also* OMB, Circular A-4.

[210] *E.g.*, EPA, 420-D-09-001, DRAFT REGULATORY IMPACT ANALYSIS:CHANGES TO RENEWABLE FUEL STANDARD PROGRAM 690 tbl. 5.3-4 (2009).

[211] *Compare* EPA, Regulatory Impact Analysis for the Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants, EPA-452/R-14-002, at tbl. ES-5 (2014) (listing multiple unquantified effects from co-pollutants, but marking "global climate impacts from CO_2" as fully monetized) *with* Peter Howard, *Omitted Damages: What's Missing from the Social Cost of Carbon* (Cost of Carbon Project Report, 2014) (detailing the many significant effects not quantified in the SCC).

We also suggest that EPA encourage the IWG to regularly update the SCC and Social Cost of Methane, as new economic and scientific consensus emerges. Such updates are in line with the stated intentions of the IWG, which committed to "updating these estimates as the science and economic understanding of climate change . . . improves."

Sincerely,

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