Think Global: International Reciprocity as Justification for a Global Social Cost of Carbon

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I. INTRODUCTION

President Obama's administration adopted a global perspective toward measuring the effects of U.S. climate change regulations and calculated the global benefits of U.S. reductions in greenhouse gas emissions. The Obama administration justified this perspective in part on the globally interconnected economics and science of climate change: the United States directly benefits when foreign countries reduce their greenhouse gas emissions, and so it is in U.S. interests to encourage foreign countries to take a global perspective on climate change by modeling that perspective ourselves. Federal agencies' various statutory authorities to regulate greenhouse gases support—and may require—this global perspective. The Trump administration is expected to break sharply from President Obama's approach to climate change regulation. However, in any attempts to roll back regulatory requirements for greenhouse gas reductions, legal standards may force the Trump administration to consider the globally interconnected climate damages caused by deregulation. This Article outlines both the economic arguments for why a global perspective on climate costs and benefits is in the interest of the

United States, and the legal arguments for why a global perspective may be required in any regulatory or deregulatory actions on climate change.[1]

To control U.S. emissions of carbon dioxide, methane, and other greenhouse gases despite the absence of any new, meaningful congressional legislation on climate change, President Obama turned to regulatory authorities already existing in statute. His 2013 Climate Action Plan called for new regulations of, for example, carbon dioxide emissions from power plants, methane emissions throughout the economy, transportation fuel economy, and energy efficiency in appliances, lighting, and buildings.[2] Using existing authorities under the Clean Air Act, the Energy Policy and Conservation Act, and other statutes, the Environmental Protection Agency ("EPA"), Department of Energy, Department of Transportation, and Department of the Interior responded with dozens of regulations to protect our economy, health, security, and the environment.

By presidential orders dating back to the Reagan administration, every major regulation—or deregulation—must be accompanied by an economic analysis showing that the rule's benefits justify its costs.[3] To evaluate the benefits of climate regulations as well as the costs of federal actions that may increase greenhouse gas emissions, a federal interagency working group developed a metric called the "social cost of carbon," which attempts to measure the marginal global damages of each additional ton of carbon dioxide—that is, the worldwide damages to agriculture, property values, health, and so forth. The value is currently about $40 per ton of carbon dioxide.[4] The interagency working group has also developed a

1. By a global perspective on the costs of climate regulation, we mean that if U.S. regulation is anticipated to increase greenhouse gas emissions, federal agencies should account for the global damages of those increased emissions. To the extent that U.S. regulations that reduce greenhouse gas emissions motivate other countries to make reciprocal emissions cuts, U.S. agencies do not count the global compliance costs of those reciprocal foreign actions.

2. EXEC. OFFICE OF THE PRESIDENT, THE PRESIDENT'S CLIMATE ACTION PLAN (2013).

3. Exec. Order No. 12,291, 46 Fed. Reg. 13,193, § 2(b) (Feb. 17, 1981); Exec. Order No. 12,866, 58 Fed. Reg. 51,735, § 6(a)(3)(C) (Sept. 30, 1993) (revoking Executive Order 12,291, but keeping the requirement that regulatory action be justified by a cost-benefit analysis); Exec. Order No. 13,563, 76 Fed. Reg. 3821, § 1(b) (Jan. 18, 2011) (affirming Executive Order 12,866's requirements).

4. INTERAGENCY WORKING GRP. ON SOC. COST OF GREENHOUSE GASES, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12,866, at 4 (2016) [hereinafter 2016 TSD]; *see also* INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, TECHNICAL SUPPORT DOCUMENT:

"social cost of methane" metric, currently around $1200 per ton of methane (methane is, pound for pound, a much more potent greenhouse gas than carbon dioxide).[5] Like the social cost of carbon, the social cost of methane values global damages.

Typically, U.S. regulatory impact analyses focus on costs and benefits to the United States, since many U.S. regulations only or predominately affect the United States.[6] However, the Obama administration reasoned that climate regulations are a special category requiring an international perspective on costs and benefits. Greenhouse gases mix freely in the atmosphere and affect the climate worldwide: U.S. emissions affect every other country, and foreign emissions affect the United States. If every country considers only the domestic costs of emissions within its own borders (or, conversely, only the domestic benefits of emissions reductions) and ignores the global externality, no country will ever reach the efficient level of emissions reductions. As the interagency working group on the social cost of carbon explained:

> Emphasizing the need for a global solution to a global problem, the United States has been actively involved . . . in encouraging other nations . . . to take significant steps to reduce emissions. When these

SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12,866 (2010) [hereinafter 2010 TSD]. The working group calculated the central estimate for year 2015 emissions at $36 in 2007 USD. Inflating this value to 2016 USD using the Bureau of Labor Statistics' CPI Inflation Calculator gives a value of about $42.

5. INTERAGENCY WORKING GRP. ON SOC. COST OF GREENHOUSE GASES, ADDENDUM TO TECHNICAL SUPPORT DOCUMENT ON SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12,866: APPLICATION OF THE METHODOLOGY TO ESTIMATE THE SOCIAL COST OF METHANE AND THE SOCIAL COST OF NITROUS OXIDE, at 7 (2016) [hereinafter 2016 ADDENDUM]. The working group calculated the central estimate for year 2015 emissions at $1000 in 2007 USD. Inflating this value to 2016 USD using the Bureau of Labor Statistics' CPI Inflation Calculator gives a value of about $1164. The interagency working group also calculated a social cost of nitrous oxide (about $15,000), but since that number has not yet been applied in regulatory impact analyses, this Article does not focus on the social cost of nitrous oxide.

6. For example, as explained by the U.S. Office of Management and Budget and Secretariat General of the European Commission in 2008, despite trade treaties, U.S. regulatory impact assessments do not usually consider the extraterritorial costs or benefits or trade impacts of regulation. U.S. OFFICE OF MGMT & BUDGET & SECRETARIAT GEN. OF THE EUROPEAN COMM'N, REVIEW OF APPLICATION OF EU AND US REGULATORY IMPACT ASSESSMENT GUIDELINES ON THE ANALYSIS OF IMPACTS ON INTERNATIONAL TRADE AND INVESTMENT, at 11–13 (2008). However, U.S. regulatory impact assessments do typically give equal consideration to costs and benefits experienced by foreign entities operating in the United States. For example, when the Department of Transportation issues fuel economy regulations, costs to Toyota count equally as costs to Ford. *Id.* at 13 n.5.

> considerations are taken as a whole, the interagency group concluded that a global measure of the benefits from reducing U.S. emissions is preferable.[7]

Moreover, given our multiple global interconnections—through the economy, national security, migration patterns, and communicable disease transmission—harms experienced in other parts of the world can quickly become costs to the United States, and so as a practical matter it is nearly unworkable to accurately isolate a domestic-only portion of the social costs of carbon or methane.[8] Thus, since 2010, nearly every U.S. regulatory impact analysis of climate controls has focused on the global social cost of carbon or the global social cost of methane.

The global focus has recently and increasingly come under attack. In May 2015, industry groups filed a brief in the U.S. Court of Appeals for the Seventh Circuit, challenging the Department of Energy's efficiency standards for commercial refrigeration equipment,[9] which the agency promulgated under the Energy Policy and Conservation Act ("EPCA").[10] The petitioners objected to the alleged "mismatch in the [social cost of carbon] analysis looking to global benefits." According to the petitioners, "EPCA authorizes [the agency] to conduct only a national analysis. There are no references to global impacts in the statute."[11] On August 8, 2016, the Seventh Circuit held that the agency "acted reasonably" in calculating the "global benefits" of its energy efficiency standards;[12] it remains to be seen whether other courts will follow this ruling. Notably, in February 2016, industry groups and several states filed a brief in the U.S. Court of Appeals for the D.C. Circuit, challenging EPA's Clean Power Plan regulation of carbon dioxide from the electricity sector, which the agency promulgated under the Clean Air Act ("CAA").[13] The challengers, among their claims,

7. 2010 TSD, *supra* note 4, at 11.

8. *Id.*

9. Brief for Petitioners at 28–30, Zero Zone v. Dep't of Energy, 832 F.3d 654 (7th Cir. 2016) (No. 14-2147).

10. Energy Policy and Conservation Act, Pub. L. No. 94–163, 89 Stat. 871 (1975).

11. Brief for Petitioners, *supra* note 9, at 28–30.

12. *Zero Zone*, 832 F.3d at 679. In our roles as staff at the Institute for Policy Integrity, the authors participated in this case as amici curiae, and the court credited our brief as "highlight[ing]" the issues surrounding the agency's use of the social cost of carbon, including a defense of the global social cost of carbon. *Id.* at 677 n.23.

13. Opening Brief for Petitioners on Procedural and Record-Based Issues at 70, West Virginia v. EPA, No. 15-1363 (D.C. Cir. Feb. 19, 2016).

objected that "the CAA expressly forecloses use of the Global Social Cost of Carbon because foreign benefits exceed the cost-benefit analysis' permissible scope. The Act's purpose is exclusively domestic. . . . Only 10% of the claimed global benefits from reducing CO_2 [carbon dioxide] emissions accrue to the United States."[14] That case is still pending as of this Article's writing.

Moving from the courthouse to academia, though much of the academic literature to date strongly supports a global social cost of carbon,[15] economists Ted Gayer and W. Kip Viscusi have recently led a small academic charge against the global valuation. In a 2016 paper, they lambast the global valuation as unauthorized by statute, inconsistent with past best practices, unjustified economically due to "elusive" international reciprocity and "fractional" altruism, and a precedent that could lead to the impoverishment of the United States for the sake of foreign welfare.[16] Joined by five other policy experts, they published a letter to the editor in *Science*[17] and a column in *Forbes*[18] and submitted a letter to a National Academies of Science committee charged with reviewing the social cost of

14. *Id.*

15. *E.g.*, Frank Ackerman & Elizabeth A. Stanton, *Climate Risks and Carbon Prices: Revising the Social Cost of Carbon,* 6 ECONOMICS 1, 2 (2012); Michael Greenstone et al., *Developing a Social Cost of Carbon for US Regulatory Analysis: A Methodology and Interpretation*, 7 REV. ENVTL. ECON. & POL'Y 23 (2013) (reviewing the policy justifications for a global value and the practical complications of a domestic-only value); Celine Guivarch et al., *Letters: Social Cost of Carbon: Global Duty*, 351 SCIENCE 1160 (2016); 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, 208 (2012) ("Empirical, theoretical, and ethical arguments strongly support the use of a global value."); Robert Kopp & Bryan Mignone, *Circumspection, Reciprocity, and Optimal Carbon Prices*, 120 CLIMATIC CHANGE 831, 831 (2013) ("[T]he domestically optimal price approaches the global cooperative optimum linearly with increasing circumspection and reciprocity."); William Pizer et al., *Using and Improving the Social Cost of Carbon*, 346 SCIENCE 1189, 1190 (2014) ("[T]he moral, ethical, and security issues . . . [and the] strategic foreign relations question . . . are compelling reasons to focus on a global [social cost of carbon]."); Richard L. Revesz et al., *The Social Cost of Carbon: A Global Imperative*, 11 REV. ENVTL. ECON. & POL'Y (forthcoming 2017).

16. Ted Gayer & W. Kip Viscusi, *Determining the Proper Scope of Climate Change Policy Benefits in U.S. Regulatory Analyses: Domestic Versus Global Approaches*, 10 REV. ENVTL. ECON. & POL'Y 245 (2016).

17. Art Fraas et al., *Social Cost of Carbon: Domestic Duty*, 351 SCIENCE 569 (2016); *see also* Susan Dudley & Brian Mannix, *The Social Cost of Carbon*, FEDERALIST SOC'Y FOR L. & PUB. POL'Y STUD. (Jul. 24, 2014), http://www.fed-soc.org/publications/detail/the-social-cost-of-carbon [https://perma.cc/NT8X-UEVR].

18. Susan Dudley et al., *How Much Will Climate Change Rules Benefit Americans?*, FORBES (Feb. 9, 2016), http://www.forbes.com/sites/susandudley/2016/02/09/how-much-will-climate-change-rules-benefit-americans [https://perma.cc/35HV-PQWC].

carbon[19]—all calling for at least an equal emphasis on the domestic-only social cost of carbon. NERA Economic Consulting has picked up on these arguments and applied them as a critique against the global social cost of methane as well.[20]

Even within the federal government, a few individual agencies have tried to break from the global focus. Some federal agencies have declined to include the social costs of carbon or methane in their environmental impact statements, perhaps because of global versus domestic concerns. In November 2015, under court order to consider the climate costs of approving new coal mines on federal lands, the U.S. Forest Service prepared a draft environmental impact statement that applied the social cost of carbon. However, after presenting both global and domestic-only estimates of the climate effects, the Forest Service concluded that

> if concerns are limited to potential [greenhouse gas] damages to the U.S. population, the proposed action is acceptable (or neutral). If decisions account for the potential impacts of the proposed action on populations outside the U.S., as represented by the Global boundary stance, then present net value results suggest that no-action might be the preferred alternative.[21]

The Forest Service's draft statement proceeded to propose taking the actions necessary to authorize the new coal mines, suggesting its decision had been based on a domestic-only perspective, rather than the global framework used in virtually every other federal climate regulation since 2010. After receiving comments from academics and environmental advocates,[22] in November 2016, the Forest Service dropped its presentation of domestic-only estimates

19. Letter from Art Fraas et al. to the Nat'l Acad. of Sci., Eng'g & Med., *Should the Federal Regulatory Agencies Report Benefits to Americans from Mandated Reductions in Greenhouse Gas Emissions?* (Feb. 8, 2016), http://www.rff.org/blog/2016/should-federal-regulatory-agencies-report-benefits-americans-mandated-reductions [https://perma.cc/VTN5-5SDX].

20. ANNE E. SMITH ET AL., NERA ECON. CONSULTING, TECHNICAL COMMENTS ON THE SOCIAL COST OF METHANE AS USED IN THE REGULATORY IMPACT ANALYSIS FOR THE PROPOSED EMISSIONS STANDARDS FOR NEW AND MODIFIED SOURCES IN THE OIL AND NATURAL GAS SECTOR (2015).

21. U.S. FOREST SERV., RULEMAKING FOR COLORADO ROADLESS AREAS: SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT, at 100 (2015).

22. *E.g.*, Joint comments from Envtl. Def. Fund et al. to Forest Serv. et al. on proposed exception to Colorado Roadless Rule (Jan. 15, 2016), http://policyintegrity.org/documents/Forest_Service_SDEIS_comments.pdf [https://perma.cc/EEE7-TN88]. The authors of this Article were signatories on those comments.

and focused on the global costs of the greenhouse gas increases resulting from new coal mines.[23]

This paper responds to these various challenges and defends a global focus for the social costs of carbon and methane. Part II offers background on the social costs of carbon and methane and their use to date by federal agencies. Parts III, IV, and V detail the various economic, strategic, ethical, and legal justifications for U.S. agencies to focus on the global value of greenhouse gas emissions. Specifically, Part III details international reciprocity as a justification; Part IV provides additional policy justifications, including the inevitability of significant "spillover" effects and the United States' willingness to pay to prevent climate damages occurring outside U.S. borders; and Part V explains, especially in light of strategic goals like reciprocity, that U.S. and international laws at least allow and may require consideration of the global effects of U.S. climate policy. These legal mandates may apply equally to any future deregulatory proposals that could increase the global costs of climate change.

The economy, public health, national security, environmental quality, and general social welfare of the United States all stand to benefit tremendously if foreign countries take efficient action on climate change. One prudent strategy to encourage efficient international reciprocity is for the United States to continue taking a global perspective on its own climate actions. In short, to safeguard its own national interests and maximize benefits locally, the United States should continue to think globally.

II. DEVELOPMENT AND USE OF THE SOCIAL COST METRICS

Carbon dioxide and methane are the two greenhouse gases most responsible for the heat-trapping effects that drive global climate change.[24] The "social cost of carbon" ("SCC") is a framework for estimating the monetized, global damages caused by releasing an additional ton of carbon dioxide into the atmosphere. Similarly, the "social cost of methane" ("SCM") is a framework for estimating

23. U.S. FOREST SERV., RULEMAKING FOR COLORADO ROADLESS AREAS: SUPPLEMENTAL FINAL ENVIRONMENTAL IMPACT STATEMENT, at 2 (2016). Even as it adopted a global focus on climate costs, the Forest Service simultaneously revised downward its estimate of total greenhouse gas emissions attributable to the agency actions, and so ultimately still recommended approval for the new coal mines.

24. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2013, SUMMARY FOR POLICYMAKERS, at 14 (2013).

the monetized, global damages caused by releasing an additional ton of methane into the atmosphere. A complete list of global damages would include all economic impacts from climate change: lost agricultural and labor productivity, property losses from sea-level rise, trade and energy supply disruptions, negative public health consequences, ocean acidification, extreme weather events, flooding, wildfires, increased pests and pathogens, water shortages, migration, regional conflicts, and loss of biodiversity and ecosystem services, among others.

This Part details the development of the SCC and SCM metrics, the standard rationale for choosing global values, and the use of the SCC and SCM metrics in over eighty regulatory analyses and environmental impact statements. Note that while valuations for additional greenhouse gases, such as nitrous oxide, have also been developed, they have not yet been fully incorporated into agencies' economic analyses.[25]

A. History and Development of the Social Cost of Carbon

Through 2007, agencies' regulatory analyses did not typically quantify, let alone monetize, greenhouse gas emissions.[26] For instance, when the Department of Transportation's National Highway Traffic Safety Administration ("NHTSA") finalized new fuel economy standards for light-duty trucks in 2006, it did not assign a dollar value to the rule's climate benefits. While acknowledging that the rule would significantly reduce carbon dioxide emissions, the agency concluded that too much uncertainty existed to monetize those benefits.[27] The rule was challenged by a group of states and environmental organizations, and in 2007 the

25. The interagency working group released an estimate of the social cost of nitrous oxide in August 2016, *see* 2016 ADDENDUM, *supra* note 5, and agencies should now begin using those numbers. In one previous rulemaking, EPA and the Department of Transportation had conducted a sensitivity analysis incorporating a social cost of nitrous oxide, both directly valued and indirectly valued through nitrous oxide's relative global warming potential. Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Phase 2, 80 Fed. Reg. 40,138, 40,458–62 (proposed July 13, 2015). However, these numbers were used in the sensitivity analysis only, not in the main regulatory analysis.

26. U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-14-663, REGULATORY IMPACT ANALYSIS: DEVELOPMENT OF SOCIAL COST OF CARBON ESTIMATES, at 5 n.11 (2014) ("According to EPA officials, other regulations at the time [in 2006] did not typically quantify changes in carbon emissions.").

27. Average Fuel Economy Standards for Light Trucks Model Years 2008–2011, 71 Fed. Reg. 17,566, 17,589 (Apr. 6, 2006).

U.S. Court of Appeals for the Ninth Circuit held that the agency had arbitrarily "assigned no value to the most significant benefit of more stringent [fuel economy] standards: reduction in carbon emissions."[28] The court explained that while there was uncertainty in the "range of values, the value of carbon emissions reduction is certainly not zero."[29]

Following that ruling, agencies began to develop their own estimates of the value of carbon reductions, with inconsistent results. Some agencies initially refused to consider anything beyond the domestic climate benefits. For example, in 2008 the Department of Energy began estimating the value of carbon reductions at $0–$20 per ton in its energy efficiency standards. This range reflected domestic-only effects. The agency concluded, without much explanation, that "the value should be restricted to a representation of those costs/benefits likely to be experienced in the United States," simply because the agency takes a domestic-only focus on "most of the estimates of costs and benefits" in its rules.[30] Similarly, in a 2008 proposed rule on passenger car fuel economy, the NHTSA estimated $7 as the domestic benefits of reducing a ton of carbon dioxide, derived as the midpoint of a range of $0–$14. The agency found that, while the global benefits were unlikely to be zero, it was still possible that U.S. benefits would be zero or even negative; $14 was an estimate of worldwide benefits and, according to the agency, therefore a maximum upper-bound estimate of U.S. benefits.[31]

28. Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 508 F.3d 508, 531 (9th Cir. 2007). The Ninth Circuit withdrew and replaced its 2007 opinion with a new one in 2008, with some changes to other parts of the ruling, but the opinion remained effectively unchanged on the issue of valuing carbon emissions. *See* Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1199 (9th Cir. 2008) ("Yet, NHTSA assigned no value to the most significant benefit . . . .").

29. *Ctr. For Biological Diversity*, 508 F.3d at 533.

30. Energy Conservation Program for Commercial and Industrial Equipment: Packaged Terminal Air Conditioner and Packaged Terminal Heat Pump Energy Conservation Standards, 73 Fed. Reg. 58,772, 58,813 n.22 (Oct. 7, 2008); *see also* Energy Conservation Program: Energy Conservation Standards for Certain Consumer Products (Dishwashers, Dehumidifiers, Microwave Ovens, and Electric and Gas Kitchen Ranges and Ovens) and for Certain Commercial and Industrial Equipment (Commercial Clothes Washers), 74 Fed. Reg. 16,040 (Apr. 8, 2009); Energy Conservation Program for Commercial and Industrial Equipment: Energy Conservation Standards for Commercial Ice-Cream Freezers; Self-Contained Commercial Refrigerators, Commercial Freezers, and Commercial Refrigerator-Freezers Without Doors; and Remote Condensing Commercial Refrigerators, Commercial Freezers, and Commercial Refrigerator-Freezers, 74 Fed. Reg. 1092 (Jan. 9, 2009).

31. Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011–2015, 73 Fed. Reg. 24,352, 24,414 (May 2, 2008).

However, by 2009, both the National Highway Traffic Safety Administration and the Department of Energy were considering global as well as domestic values. When the NHTSA finalized its passenger car fuel economy standards in 2009, the agency noted that "no [public] commenters supported NHTSA's use of $0/ton as the lower bound estimate."[32] Instead, the agency used both a domestic estimate of $2 per ton and a global estimate of $33 per ton (along with a sensitivity analysis at $80 per ton).[33] The agency concluded that it alone could not resolve the global versus domestic argument, and called for coordination among federal agencies and "leadership from the Administration."[34] The agency noted that the current state of "negotiations regarding effective international cooperation" could affect this decision; at the time, the agency felt such considerations necessitated at least some domestic-only estimate, on the assumption that ambitious "unilateral" action by a single country would not be matched by other countries.[35] Later that year, the Department of Energy copied the National Highway Traffic Safety Administration's approach and "concluded it was appropriate to consider the global benefits of reducing [carbon dioxide] emissions, as well as the domestic benefits."[36]

Beginning in its first advance notice of proposed regulation of greenhouse gas emissions in 2008 (under the George W. Bush administration), EPA considered both global values ($40 or $68 per ton of carbon dioxide, depending on the discount rate) and domestic values ($1 or $4 per ton, depending on the discount rate).[37] EPA explained it was appropriate to consider a global value

32. Average Fuel Economy Standards Passenger Cars and Light Trucks Model Year 2011, 74 Fed. Reg. 14,196, 14,341 (Mar. 30, 2009). Nor did any commenters support $14 as the upper-bound estimate.

33. Sensitivity analyses are used to determine how sensitive a calculation is to a particular outcome. In this case, while the agency believed the SCC would most likely be between $2 and $33 per ton, it also analyzed the rule's benefits assuming that the SCC instead was $80 per ton. *See id.*

34. *Id.* at 14,350.

35. *Id.* at 14,349.

36. Energy Conservation Program: Energy Conservation Standards and Test Procedures for General Service Fluorescent Lamps and Incandescent Reflector Lamps, 74 Fed. Reg. 34,080, 34,163 (July 14, 2009); *see also* Energy Conservation Program for Certain Industrial Equipment: Energy Conservation Standards and Test Procedures for Commercial Heating, Air-Conditioning, and Water-Heating Equipment, 74 Fed. Reg. 36,312, 36,343 (July 22, 2009).

37. Advanced Notice of Proposed Rulemaking on Regulating Greenhouse Gas Emissions Under the Clean Air Act, 73 Fed. Reg. 44,354, 44,446 (July 30, 2008).

because "economic principles suggest that the full costs to society of emissions should be considered in order to identify the policy that maximizes the net benefits to society, i.e., achieves an efficient outcome."[38] The agency further explained that a global estimate better captured the fact that U.S. citizens value international impacts, due to tourism and other concerns; that the United States itself has international interests, such as national security and economic disruptions in other countries that could affect the U.S. economy; and that "domestic mitigation decisions [may] affect the level of mitigation and emissions changes in general in other countries (i.e., the benefits realized in the U.S. will depend on emissions changes in the U.S. and internationally)."[39] EPA continued this approach in its 2009 proposed renewable fuel standards, only with different estimates: global estimates (ranging from -$4 to $159 per ton) and domestic estimates (ranging from $0 to $16 per ton).[40]

By 2009, the need to harmonize the divergent estimates and approaches across federal agencies was apparent. The Obama White House's Council of Economic Advisers and Office of Management and Budget convened an interagency working group to calculate a consistent and transparent range of SCC values to use in setting and evaluating all U.S. climate regulations. With input from the Environmental Protection Agency; the Departments of Agriculture, Commerce, Energy, Transportation, and Treasury; and the White House's Office of Information and Regulatory Affairs, Council on Environmental Quality, National Economic Council, Office of Energy and Climate Change, and Office of Science and Technology Policy, the interagency group finalized its first SCC estimates in 2010, after preliminary estimates had been released in 2009.[41] These estimates were followed by an update in 2013 to use the newest versions of the underlying methodological tools, and by slight updates again in 2015 and 2016.[42]

38. *Id.* at 44,415.

39. *Id.*; *accord* Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 74 Fed. Reg. 24,094, 25,096 (May 26, 2009).

40. Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 74 Fed. Reg. 24,904, 25,094 (May 26, 2009).

41. *See* 2010 TSD, *supra* note 4.

42. *See* 2016 TSD, *supra* note 4; INTERAGENCY WORKING GRP. ON THE SOC. COST OF CARBON, TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12,866 (2015) [hereinafter 2015 TSD]; INTERAGENCY WORKING GRP. ON THE SOC. COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: TECHNICAL

Because carbon dioxide accumulates in the atmosphere over time and climate damages escalate as temperature rises, a ton of carbon dioxide emitted next year is marginally more damaging than one emitted today, and so the SCC estimates rise over time. The interagency group calculates a range of four estimates, largely based on different discount rate assumptions.[43] Focusing on the central of the four estimates (corresponding to a 3% discount rate) and adjusting the calculations for inflation, the interagency group calculated the following values for the marginal global costs of emitting an additional ton of carbon dioxide:

Table 1: Global SCC by Year of Emission[44]

Year of Emission	2010	2015	2020	2025	2030	2035	2040	2045	2050
Global SCC (2016$)	$36	$43	$49	$53	$59	$64	$70	$74	$80

These estimates reflect much of the latest, peer-reviewed scientific and economic literature. Nevertheless, studies indicate that these SCC numbers are almost certainly underestimates of true global damages—perhaps severe underestimates.[45] Using different discount rates; selecting different models; applying different treatments to uncertainty, climate sensitivity, and the potential for catastrophic damages; and making other reasonable assumptions could yield very different, and much larger, SCC estimates.[46] In a recent report, one of the authors here found that current SCC estimates omit or poorly quantify damages to the following sectors:

UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12,866 (2013) [hereinafter 2013 TSD].

43. Discount rates reflect the fact that a dollar today is worth more than a dollar tomorrow, and translate a stream of future costs and benefits into their net present value.

44. Estimates from the 2015 technical support document, *see* 2015 TSD, *supra* note 42, have been adjusted for inflation to 2016 USD. *See supra* note 5 (explaining this Article's inflation adjustment methodology).

45. *See* Richard L. Revesz, Peter H. Howard, Kenneth Arrow, Lawrence H. Goulder, Robert E. Kopp, Michael A. Livermore, Michael Oppenheimer, & Thomas Sterner, *Global Warming: Improve Economic Models of Climate Change*, 508 NATURE 173 (2014) (citing technical studies); *see also* Peter H. Howard & Derek Sylvan, *The Economic Climate: Establishing Expert Consensus on the Economics of Climate Change* 29–38 (Inst. for Pol'y Integrity, Working Paper No. 2015/1, 2015) (surveying experts).

46. *See* Revesz et al., *supra* note 45; Joint comments from Inst. for Pol'y Integrity et al. to Office of Info. and Regulatory Affairs on Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order No. 12,866 (Feb. 26, 2014), http://costofcarbon.org/files/2.26.14_Joint_Comments_to_OMB.pdf [https://perma.cc/Q64J-5DBY].

> agriculture, forestry, and fisheries (including pests, pathogens, and weeds, erosion, fires, and ocean acidification); ecosystem services (including biodiversity and habitat loss); health impacts (including Lyme disease and respiratory illness from increased ozone pollution, pollen, and wildfire smoke); inter-regional damages (including migration of human and economic capital); inter-sector damages (including the combined surge effects of stronger storms and rising sea levels); exacerbation of existing non-climate stresses (including the combined effect of the over pumping of groundwater and climate-driven reductions in regional water supplies); socially contingent damages (including increases in violence and other social conflict); decreasing growth rates (including decreases in labor productivity and increases in capital depreciation); weather variability (including increased drought and inland flooding); and catastrophic impacts (including unknown unknowns on the scale of the rapid melting of Arctic permafrost or ice sheets).[47]

Though still incomplete, the SCC methodology aspires to reflect the full global costs of any additional ton of carbon dioxide released from any source anywhere in the world, or, conversely, the full global benefits of any avoided emissions. Citing both the global impacts of climate change and the coordinated global action needed to mitigate climate change, the interagency working group concluded that calculating the full global effects of U.S. emissions (as opposed to only domestic effects) is the most justified and preferred approach for measuring the benefits of U.S. climate regulations, and is consistent with legal obligations.[48]

The interagency working group did calculate a domestic estimate. Using the results of one economic model as well as the U.S. share of global gross domestic product ("GDP"), the group generated an "approximate, provisional, and highly speculative" range of 7–23% of the global SCC as an estimate of the purely direct climate effects to the United States.[49] Yet, as the interagency group acknowledged—and as discussed more thoroughly in Part IV of this article—this range is almost certainly an underestimate because it ignores significant, indirect costs to trade, human health, and security that are likely to spill over into the United States as

47. PETER HOWARD, COST OF CARBON PROJECT, OMITTED DAMAGES: WHAT'S MISSING FROM THE SOCIAL COST OF CARBON, at 5 (2014).

48. *See* 2013 TSD, *supra* note 42, at 14–15; 2010 TSD, *supra* note 4, at 10–11.

49. *See* 2010 TSD, *supra* note 4, at 11.

other regions experience climate change damages.[50] Over the course of the Obama administration, the global estimate became and remained the preferred metric of both the interagency working group and federal agencies.

B. Development of the Social Cost of Methane

Carbon dioxide is the most common greenhouse gas emitted by human activity, but it is not the most potent greenhouse gas per unit of mass. Adjusting for the comparative potency of various pollutants (also called their "global warming potentials"), the SCC can be roughly applied to calculate damages from "carbon dioxide-equivalent" amounts of other greenhouse gases besides carbon dioxide, such as methane (which is about 28–87 times more potent than carbon dioxide per ton).[51] On a few past occasions, both EPA and the National Highway Traffic Safety Administration used global warming potential-adjusted estimates of the benefits of reducing methane emissions.[52] Economic experts, however, argue that the full social costs of specific, non-carbon dioxide gases should be assessed directly through separate models, which would more accurately account for varying atmospheric life spans, among other differences.[53]

50. Indeed, the integrated assessment models used to develop the global SCC estimates largely ignore interregional costs entirely. *See* HOWARD, *supra* note 47, at 39. Though some positive spillover effects are also possible, such as technology spillovers that reduce the cost of mitigation or adaptation, *see* S. Rao et al., *Importance of Technological Change and Spillovers in Long-Term Climate Policy*, 27 ENERGY J. 123, 123–39 (2006), overall spillovers likely mean that the U.S. share of the global SCC is underestimated, *see* Jody Freeman & Andrew Guzman, *Climate Change and U.S. Interests*, 109 COLUM. L. REV. 1531 (2009).

51. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS 714 tbl.8.7 (2013). Methane's global warming potential relative to carbon dioxide depends principally on the timescale of analysis (methane has a shorter lifespan compared to carbon dioxide and so is relatively more potent over a twenty-year horizon versus a one hundred-year horizon), as well as on the source of methane (fossil methane has a higher potency than agricultural methane) and whether climate-carbon feedback is included.

52. 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624, 62,629 (Oct. 15, 2012) ("The methane co-benefits were presented for illustrative purposes and therefore not included in the total benefit estimate for the rulemaking."); NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., PHASE 2 FUEL EFFICIENCY STANDARDS FOR MEDIUM- AND HEAVY-DUTY ENGINES AND VEHICLES: DRAFT EIS (2015); NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., FINAL ENVIRONMENTAL IMPACT STATEMENT FOR FUEL EFFICIENCY STANDARDS FOR PASSENGER VEHICLES (2012).

53. *See* Disa Thureson, *The Temporal Aspects of the Social Cost of Greenhouse Gases* (Örebro Univ. Sch. of Bus., Working Paper, 2012).

In 2015, EPA began using a social cost of methane estimate (currently valued around $1200 per ton), first in sensitivity analyses,[54] and then in its primary economic analyses.[55] EPA's estimate derived from an analysis published in 2014 by A.L. Marten and other scholars in the peer-reviewed journal *Climate Policy*.[56] The authors based their analysis on the same techniques developed by the interagency working group for the social cost of carbon. Specifically, the authors used the same three integrated assessment models, five socioeconomic-emissions scenarios, equilibrium climate sensitivity distribution, three constant discount rates, and an aggregation approach that were selected for the social cost of carbon through the interagency working group's transparent, consensus-driven, and publicly reviewed process. Therefore, like the SCC calculation, Marten et al.'s SCM calculation is a global valuation. EPA also conducted internal and peer reviews of the Marten et al. approaches before using them in analyses.[57]

The Interior Department's Bureau of Land Management was the first agency to copy EPA's approach to the social cost of methane,[58] followed by the Department of Transportation in a regulatory impact analysis.[59] In August 2016, the interagency working group

54. Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Phase 2, 80 Fed. Reg. 40,138, 40,461 tbl.IX-19 (July 13, 2015). The SCM estimates are higher but of a roughly similar magnitude as global warming potential ("GWP") adjusted-estimates for methane. *See id.* at 40,462 ("[C]ompared to the use of directly modeled estimates, the GWP-based approximation approach underestimates the climate benefits of the CH_4 emission reductions by 12 percent to 52 percent."). Importantly, unlike the global warming potential-adjusted estimates, the direct estimation of the SCM accounts for the quicker time horizon of methane's effects compared to carbon dioxide, including the indirect effects of methane on radiative forcing, and so reflects the complex, nonlinear linkages along the pathway from methane emissions to monetized damages.

55. Oil and Natural Gas Sector: Emission Standards for New and Modified Sources, 80 Fed. Reg. 56,593, 56,654 (Sept. 18, 2015); Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 80 Fed. Reg. 52,100, 52,103, 52,143 (Aug. 27, 2015); Standards of Performance for Municipal Solid Waste Landfills, 80 Fed. Reg. 52,162, 52,164 (Aug. 27, 2015).

56. Alex L. Marten et al., *Incremental CH_4 and N_2O Mitigation Benefits Consistent with the U.S. Government's SC-CO_2 Estimates*, 15 CLIMATE POL'Y 272 (2014).

57. U.S. ENVTL. PROT. AGENCY, VALUING METHANE EMISSIONS CHANGES IN REGULATORY BENEFIT-COST ANALYSIS, PEER REVIEW CHARGE QUESTIONS, AND RESPONSES (2015).

58. Waste Prevention, Production Subject to Royalties, and Resource Conservation, 81 Fed. Reg. 6615, 6624 (Feb. 8, 2016).

59. DEP'T OF TRANSP., PRELIMINARY REGULATORY IMPACT ASSESSMENT ON SAFETY OF GAS TRANSMISSION AND GATHERING PIPELINES 62 (2016).

on the social cost of carbon finally released an addendum that adopts EPA's values for the social cost of methane.[60]

C. Use of the Metrics in Regulatory and Related Proceedings

Though the SCC was first developed for use in regulatory impact analyses,[61] the methodology applied by the interagency working group was in no way unique to the regulatory process, and the estimates are applicable to other decision-making contexts. Notably, the Council on Environmental Quality approved of using the SCC metric in environmental impact statements prepared for a variety of land and natural resource use planning and other decisions under the National Environmental Policy Act ("NEPA").[62] In fact, applying both the SCC and SCM metrics in environmental impact statements may be essential to fulfilling NEPA's goals of transparent and informed decision-making.[63] Several agencies have used the SCC and SCM in their environmental impact statements, in addition to their regulatory impact analyses.

Catalogued more fully in Appendix A to this Article, at least eighty-three separate regulatory or planning proceedings conducted by six different federal agencies have used the SCC or SCM in their analyses:

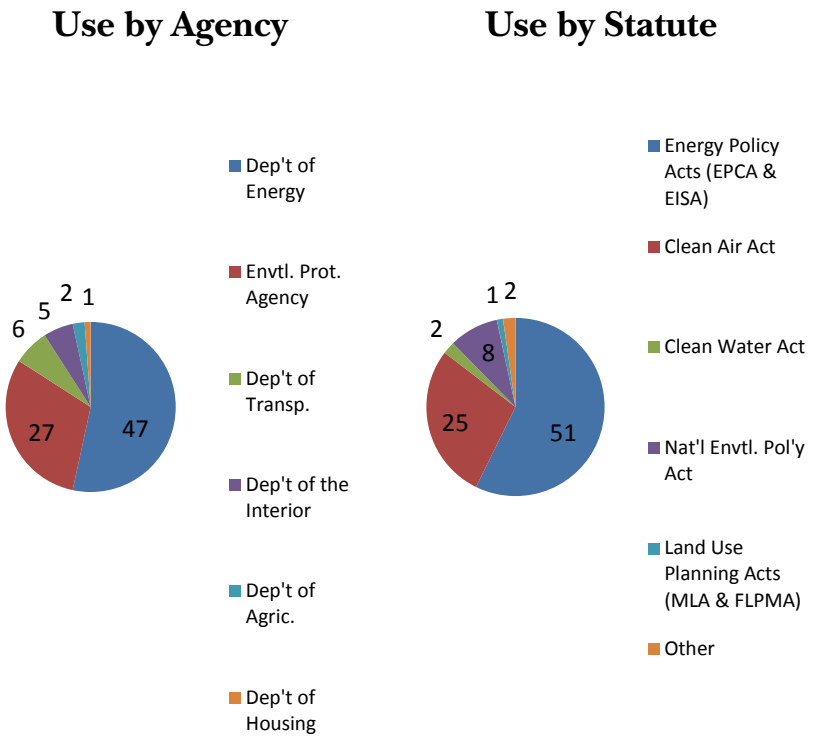
60. 2016 ADDENDUM, *supra* note 5.

61. *See* 2010 TSD, *supra* note 4 (titled "SOCIAL COST OF CARBON FOR *REGULATORY IMPACT ANALYSIS*") (emphasis added).

62. COUNCIL ON ENVTL. QUALITY, FINAL GUIDANCE FOR FEDERAL DEPARTMENTS AND AGENCIES ON CONSIDERATION OF GREENHOUSE GAS EMISSIONS AND THE EFFECTS OF CLIMATE CHANGE IN NATIONAL ENVIRONMENTAL POLICY ACT REVIEWS 33 n.86 (2016) ("Developed through an interagency process committed to ensuring that the SCC estimates reflect the best available science and methodologies and used to assess the social benefits of reducing carbon dioxide emissions across alternatives in rulemakings, [the SCC] provides a harmonized, interagency metric that can give decision makers and the public useful information for their NEPA review.").

63. *See* Joint comments from Envtl. Def. Fund et al. to Forest Serv. et al., *supra* note 22, at 4–6 (explaining how monetization best promotes NEPA's goals of presenting information to facilitate comparison across alternatives).

Chart 1: SCC & SCM in Regulatory Proceedings by Agency & Statute (Jan. 2009–July 2016)[64]



The Department of Energy is responsible for over half of those usages, followed by EPA with about a third. Notably, the Department of Energy always includes domestic calculations of the SCC in its regulatory impact analyses, even while emphasizing the global value. For example, a recent analysis of the agency's proposed energy efficiency standards for housing includes estimates of both "Global Net Present Value of Reduced Emissions of CO_2" and "Domestic Net Present Value of Reduced Emissions of

64. *See* Appendix A. Note that the numbers in these graphs may add up to more than eighty-three rulemakings, because some rulemakings involve multiple agencies and multiple statutes.

CO_2."[65] Other agencies, including EPA, have also at times included a discussion or calculation of the domestic SCC in their regulatory proposals. For example, EPA's 2011 proposed air quality performance standards for the oil and gas sector first estimated the global value of the rule's climate co-benefits, but also discussed the "provisional and highly speculative" domestic range developed by the interagency working group.[66] Nevertheless, by and large federal agencies under the Obama administration focused predominantly if not exclusively on the global SCC and SCM estimates.[67] The focus on the global metrics is well justified by legal obligations and economic principles.

III. STRATEGIC USE OF THE GLOBAL SCC CAN FOSTER INTERNATIONAL COOPERATION BENEFITING THE UNITED STATES

The world's climate is a single interconnected system, and the United States benefits greatly when foreign countries consider the global externalities of their greenhouse gas pollution and cut emissions accordingly. Game theory predicts that one viable strategy for the United States to encourage other countries to think globally in setting their climate policies is for the United States to do the same, in a tit-for-tat, lead-by-example, or coalition-building dynamic. In fact, most other countries with climate policies already use a global social cost of carbon or set their carbon taxes or allowances at prices above their domestic-only costs. President Obama's administration explicitly chose to adopt a global social cost of carbon to foster continued reciprocity in other countries' climate policies.

A. The Economics of Avoiding a Tragedy of the Global Climate Commons

The Earth's climate is a shared global resource.[68] All countries may enjoy the benefits of stable atmospheric concentrations,

65. U.S. DEP'T OF ENERGY, TECHNICAL SUPPORT DOCUMENT FOR NOTICE OF PROPOSED RULEMAKING ESTABLISHING ENERGY CONSERVATION STANDARDS FOR MANUFACTURED HOUSING 14.100–.101 tbl.14.4, 14.5 (2016).

66. Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews, 76 Fed. Reg. 52,738, 52,792 (proposed Aug. 23, 2011).

67. *See infra* Appendix A.

68. The Earth's oceans (at risk of acidification from carbon pollution) are also global common resources. Common resources are goods that are non-excludable but rivalrous. To

temperatures, and weather patterns; yet, any one country's depletion of Earth's climate stability—specifically, by emitting greenhouse gas pollution—can impose great harms on the polluting country as well as on the rest of the world.[69] Greenhouse gases like carbon dioxide and methane do not stay within geographic borders or dissipate quickly. Over life spans stretching tens, hundreds, or even thousands of years, greenhouse gases become well mixed through the planet's atmosphere and so affect climate worldwide. As a result, each ton of carbon pollution emitted by the United States, for example, not only creates domestic harms, but also imposes additional and large damages on the rest of the world. Conversely, each ton of greenhouse gases abated in any other country will benefit the United States along with the rest of the world.

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 the global damages caused by their emissions. If all countries instead set their greenhouse gas emissions 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 ruin to all."[70] Only by accounting for the full damages of their greenhouse gas pollution will countries collectively select the efficient level of worldwide emissions reductions needed to secure the planet's common climate resources.[71]

the extent that the social cost of carbon does not fully reflect damages from ocean acidification, this report does not capture the additional benefits to the United States as foreign actions to address climate change simultaneously mitigate the acidification of the world's shared oceans.

69. A handful of geographic regions may experience short-term benefits from climate change, such as temporary agricultural gains in colder regions, but even in those areas, long-term, catastrophic scenarios would bring significant harms.

70. Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243, 1244 (1968).

71. *See, e.g.*, Matthew Kotchen, *Which Social Cost of Carbon? A Theoretical Perspective* 7–8 (Aug. 12, 2016), https://cenrep.ncsu.edu/cenrep/wp-content/uploads/2015/07/Kotchen-paper.pdf [https://perma.cc/BH2A-7KGV] ("The result is intuitive: the marginal benefit of emissions is equated across all countries and equal to the sum of the marginal damages of emissions. . . . That is, all countries must internalize the GSCC [global SCC], which then defines a unique level of Pareto optimal emissions for each country.").

B. Other Countries Have Strategically Selected a Global SCC

As detailed more fully in Appendix B, numerous countries have priced carbon in a variety of ways. Canada has long followed the U.S. interagency working group's lead on the SCC, and recently Canada and Mexico joined the United States in explicitly "aligning methods for estimating the social cost of carbon."[72] Several other jurisdictions—Sweden, Germany, the United Kingdom, Norway, and the European Union—have independently developed or adopted social cost of carbon metrics for regulatory analysis.[73] All of these valuations are close to or far above the U.S. valuation, indicating that they all reflect a global view of climate damages. Sweden and Germany have the highest valuations of carbon: $167–$168 per ton in the year 2030, or more than three times the U.S. estimate. Those countries that have developed a social cost of methane, like the United Kingdom, are also using a global value.[74]

Many other countries have adopted either carbon taxes or carbon allowances that seem to reflect concern for the extra-territorial effects of greenhouse gas pollution.[75] Sweden, France, Switzerland, and Finland have carbon taxes set above the U.S. calculation of the global SCC. Sweden again leads the pack, with its carbon tax set at $130 per ton. Many other countries and jurisdictions—including Tokyo, Canadian provinces, Denmark, Ireland, Slovenia, Costa Rica, the European Union, South Korea, Iceland, South Africa, Chile, Portugal, New Zealand, Latvia, Mexico, Kazakhstan, and Estonia—have either carbon taxes or carbon allowances priced higher than a rough approximate

72. Jason Furman & Brian Deese, *The Economic Benefits of a 50 Percent Target for Clean Energy Generation by 2025*, WHITE HOUSE BLOG (June 29, 2016), https://www.whitehouse.gov/blog/2016/06/29/economic-benefits-50-percent-target-clean-energy-generation-2025 [https://perma.cc/9BWN-4VAF] (summarizing the North American Leaders' Summit announcement that the United States, Canada, and Mexico would "align" their SCC estimates); *see also* Press Release, White House Office of the Press Sec'y, U.S.-Canada Joint Statement on Climate, Energy, and Arctic Leadership (Mar. 10, 2016), https://www.whitehouse.gov/the-press-office/2016/03/10/us-canada-joint-statement-climate-energy-and-arctic-leadership [https://perma.cc/W96S-GNDA] ("Canada and the U.S. will align approaches, reflecting the best available science for accounting for the broad costs to society of the GHG emissions that will be avoided by mitigation measures, including using similar values for the social cost of carbon and other GHGs for assessing the benefits of regulatory measures.").

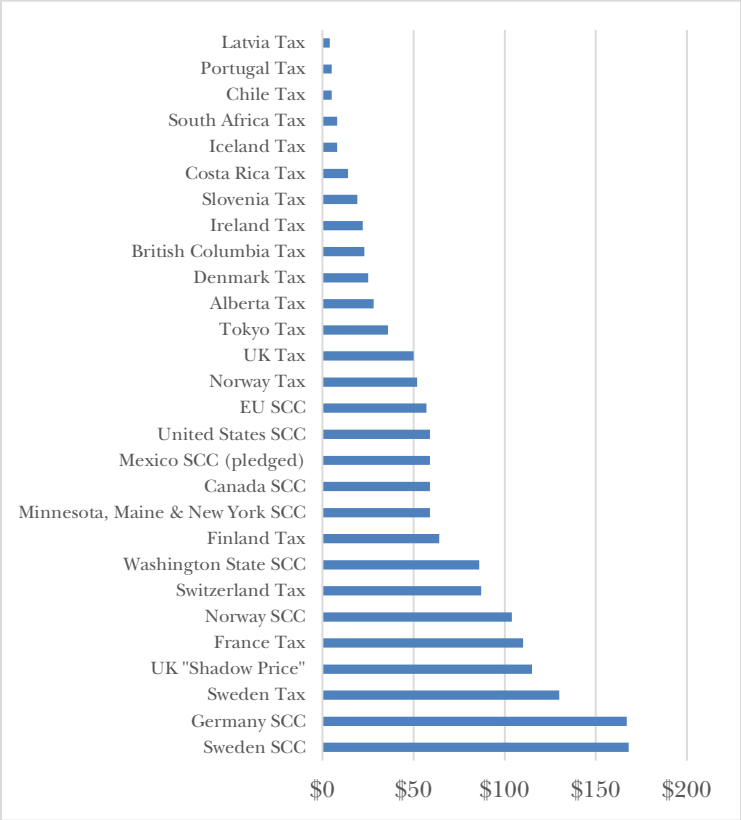
73. *See infra* Appendix B.

74. *E.g.*, DEP'T FOR ENV'T, FOOD, AND RURAL AFFAIRS, U.K., METHODOLOGICAL APPROACHES FOR USING SCC ESTIMATES IN POLICY ASSESSMENT 58 (2005) (reporting the PAGE results for the social cost of methane).

75. *See generally infra* Appendix B.

estimate of their domestic-only SCC (based on that country's share of world GDP). Only China, Japan (excluding the Tokyo trading program), and India have policies arguably priced at or below their domestic share of the SCC, but notably these carbon programs are new developments and prices could rise as targets strengthen with international reciprocity. Admittedly, taxes and allowance auctions may have revenue-generation motives separate from setting the globally efficient level of carbon reductions, but the number of countries with carbon priced above their domestic share of the SCC suggests widespread acknowledgement that countries must consider their global externalities.

Chart 2: Selected Carbon Values Worldwide (in 2016 USD, per tCO_2e, for year 2030 emissions; some tax values reflect current price)



As further evidence of how the United States' use of a global SCC value can influence other international actors to follow suit, the International Monetary Fund ("IMF") applies in its policy reviews an SCC estimate based on the U.S. interagency numbers.[76] Given the potential influence of the IMF on the environmental policies of developing countries,[77] the pull that the United States' 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.

C. Foreign Countries' Existing Policies and Pledges Promise Carbon Reductions Worth Trillions to the United States

As detailed in the authors' recent report published by the Institute for Policy Integrity, the United States has already benefited from foreign climate action and will continue to benefit tremendously if foreign countries fulfill their existing pledges for future action.[78] Based on a dataset from *Climate Action Tracker*,[79] our previous report calculates that existing foreign policies (like the European Union's Emissions Trading Scheme) have likely reduced up to twenty-four billion metric tons of carbon dioxide-equivalent emissions during the last five years alone, directly benefiting the United States by at least $60 to $231 billion.[80] Over the next fifteen years, direct U.S. benefits from global climate policies already in effect could reach over $2 trillion.[81]

Our previous work also forecasted the future emissions reductions from pledges and commitments made by foreign countries and estimated the direct U.S. share of those benefits.[82] In advance of the December 2015 Paris meeting of the United Nations Framework Convention on Climate Change, member nations,

76. *E.g.*, BENEDICT CLEMENTS ET AL., INTERNATIONAL MONETARY FUND, ENERGY SUBSIDY REFORM: LESSONS AND IMPLICATIONS 9 (2013).

77. *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").

78. PETER HOWARD & JASON SCHWARTZ, INST. FOR POL'Y INTEGRITY, FOREIGN ACTION, DOMESTIC WINDFALL (2015).

79. CLIMATE ACTION TRACKER, http://climateactiontracker.org [https://perma.cc/UXS8-XLD3] (last visited Feb. 19, 2017).

80. HOWARD & SCHWARTZ, *supra* note 78, at 11.

81. *Id.*

82. *Id.* at 11, 13.

including many countries most responsible for greenhouse gas emissions, announced numerical pledges to meet their share of necessary emissions reductions. One hundred eighty-seven countries have submitted plans, including China, India, Brazil, Australia, Japan, Europe, and the United States; [83] submissions cover countries responsible for over 95% of global emissions.[84] Though these pledged reductions are not fully enforceable (nor may they be sufficient on their own to completely solve the threats to global climate), they help put in perspective what is at stake in an international agreement to address climate change. Based on *Climate Action Tracker* data, we calculated that if these foreign reduction pledges are achieved, over the years 2015–2030 the United States could gain direct benefits of at least $54–$544 billion.[85] Multiplied over many decades of emissions reductions, direct U.S. benefits from existing and pledged foreign actions to

83. *INDCs as Communicated by Parties*, U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE, http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx [https://perma.cc/XW88-VA2Q] (last visited Feb. 19. 2017).

84. *Tracking INDCs*, CLIMATE ACTION TRACKER, http://climateactiontracker.org/indcs.html [https://perma.cc/7D7X-Y2M2] (last visited Feb. 19, 2017).

85. These estimates are consistent with estimates from employing alternate methodologies and datasets. For example, according to estimates used by the Organisation for Economic Co-operation and Development ("OECD") and compared to a business-as-usual scenario, pledges from the 2009 Copenhagen Accords could result in reductions in the year 2020 of between 2.3 billion metric tons of carbon dioxide-equivalents (for the least ambitious end of the pledges) to 9 billion metric tons (in the most optimistic scenario). INT'L TRANSP. FORUM, OECD, REDUCING TRANSPORT GREENHOUSE GAS EMISSIONS: TRENDS AND DATA 25 (2010); *see also* Joeri Rogelj et al., *Analysis of the Copenhagen Accord Pledges and Its Global Climatic Impacts—A Snapshot of Dissonant Ambitions*, 5 ENVTL. RES. LETTERS 1, 5–6 (2010); Joeri Rogelj et al., *Copenhagen Accord Pledges Are Paltry*, 464 NATURE 1126 (2010). The U.S. share of these pledges is equal to about a 1.1 billion metric ton reduction in the year 2020 on the low-ambition end, and 1.3 billion on the high-ambition end. *See* M.G.J. DEN ELZEN ET AL., NETH. RESEARCH PROGRAMME ON SCI. ASSESSMENT & POL'Y ANALYSIS FOR CLIMATE CHANGE, WAB 500102 032, PLEDGES AND ACTIONS: A SCENARIO ANALYSIS OF MITIGATION COSTS AND CARBON MARKET IMPACTS FOR DEVELOPED AND DEVELOPING COUNTRIES 35–38 tbl.2.1, 2.2 (2009) (citing a business-as-usual baseline for the United States in 2020—as developed for analysis of the Waxman-Markey legislative proposal—at 7.39 billion tons, and listing low- and high-ambition pledges for the United States as 0% to 3% below 1990 levels). *But see* U.S. ENVTL. PROT. AGENCY, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2012, at ES-7 (2014) (setting the 1990 baseline at 6.23 billion tons). That means that under Copenhagen, foreign countries alone pledged between a 1.2 billion metric ton and 7.7 billion metric ton reduction in the year 2020. If all Copenhagen pledges were achieved (including U.S. pledges), total global benefits will be between $110 billion and $432 billion from worldwide carbon reductions just in the year 2020. The direct U.S. share of purely foreign emissions reductions would be at least between $4 billion and $85 billion, again just in the year 2020. The magnitude of the estimates from this alternate methodology is consistent with our previous report's preferred methodology based on *Climate Action Tracker* data, and so supports this Article's overall conclusions.

combat climate change could easily reach into the trillions of dollars.[86]

While there is much uncertainty in all these estimates, it is worth remembering that two key figures—the social cost of carbon and the U.S. share of climate damages—are based on conservative methodologies and are very likely to underestimate actual benefits to the United States of foreign action on climate change. For example, not only does the social cost of carbon framework currently omit many significant, unquantified climate effects and interregional spillovers, but it also does not factor in a number of important ancillary benefits to U.S. health and welfare, including the reduction of co-pollutants like mercury that also drift into the United States from foreign countries.

In short, the United States has much at stake in securing efficient levels of foreign action on climate change. Game theory predicts that one viable strategy to foster reciprocity is for the United States to consider the global effects of its policies as well.

D. Game Theory and International Reciprocity

Economic models of strategic behavior and real-world experiments suggest the United States may be able to stimulate cooperative international action by leading by example; building trust, a reputation for equity, and a critical mass of initial actors; and promoting a tit-for-tat dynamic of mutually beneficial reciprocity between nations.

86. These estimates do not reflect the U.S. benefits of foreign actions under two other international agreements recently finalized in October 2016. First, nearly 200 countries, including the United States, agreed to phase out a particularly potent category of greenhouse gases called hydrofluorocarbons. Press Release, White House Office of the Press Sec'y, Fact Sheet: Nearly 200 Countries Reach Global Deal to Phase Down Potent Greenhouse Gases and Avoid Up to 0.5°C of Warming (Oct. 15, 2016), https://obamawhitehouse.archives.gov/the-press-office/2016/10/15/fact-sheet-nearly-200-countries-reach-global-deal-phase-down-potent [https://perma.cc/F8UC-G56J]. Second, the United States and 190 other countries agreed to targets to reduce greenhouse gas emissions from international flights. Press Release, White House Office of the Press Sec'y, Fact Sheet: 191 Countries Reach a Global Climate Deal for International Aviation (Oct. 6, 2016), https://obamawhitehouse.archives.gov/the-press-office/2016/10/06/fact-sheet-191-countries-reach-global-climate-deal-international [https://perma.cc/N732-PEZC]. A similar agreement on international marine emissions of greenhouse gases is being negotiated. *See Marine Environment Protection Committee (MEPC), 70th session, 24-28 October 2016*, INT'L MAR. ORG. (Oct. 28, 2016), http://www.imo.org/en/MediaCentre/MeetingSummaries/MEPC/Pages/MEPC-70th-session.aspx [https://perma.cc/M38D-UGUD].

Mathematical models of strategic behavior can help predict how economic agents and governments will act when their welfare depends on the decisions of others.[87] Such methods have been used extensively to model informal and formal negotiations among countries over climate change. One recent article identified twenty-five distinct basic structures that could apply to climate change negotiations, including well-known interactions like "the prisoner's dilemma" and "chicken."[88] Precise predictions about the likely results of climate negotiations are highly dependent on a number of key assumptions, such as forecasting which negotiation structure applies, how many nations will negotiate, whether negotiators have complete information and will behave purely rationally, how much time or how many rounds of negotiation will occur, which decision pathways will be open to policymakers, and how negotiators will perceive the payoffs of various outcomes. In short, there is no clear consensus in the economic literature about the most likely result of climate negotiations, or indeed even about which structure best models the negotiations.

Nevertheless, under a number of scenarios and assumptions, a strategy of leading by example with unilateral action could successfully induce international cooperation on climate change. For instance, in the "coordination" strategic model, all parties realize mutual welfare gains if they all choose mutually consistent strategies. A classic version is when two drivers meet on a narrow road: only when both swerve in the same direction (e.g., both to their own right) can they avoid collision. In a coordination model of climate negotiations, unilateral abatement by one major emitting country or bloc of countries can increase the incentive for other governments to also abate. In this strategy, good faith signals can build credibility and trust with other nations, which can increase those countries' perceptions that a broadly cooperative outcome is probable, which in turn actually induces cooperation. Trust-building exercises and signals can be especially useful when

87. This discipline is known as "game theory."

88. Stephen J. DeCanio & Anders Fremstad, *Game Theory and Climate Diplomacy*, 85 ECOLOGICAL ECON. 177 (2013). The classic version of "the prisoner's dilemma" involves two criminal co-conspirators being questioned by police in separate rooms, where each ends up implicating the other since their physical separation prevents them from collaboratively making a mutually beneficial agreement to both stay silent. The classic version of "chicken" involves two vehicles speeding toward each other on a road: whichever player veers off first loses the game, but if neither player veers they both crash.

players are risk averse.[89] Calculating the global costs of U.S. emissions could provide a good faith signal that the United States cares about the welfare of other countries, and finalizing U.S. regulations that utilize the global SCC value can further increase the incentives for other governments to follow suit.

In a number of additional negotiation structures, a "tit-for-tat" strategy can prove successful in inducing cooperation, once the model reflects more realistic assumptions allowing repeat, dynamic negotiations over time. A "tit-for-tat" strategy entails matching whatever action your fellow negotiators/players took most recently: if your adversary cooperated, then you cooperate; if your adversary defected, you punish the defection by also defecting.[90] For instance, when the "prisoner's dilemma" model assumes that two decision-makers will each have only a single opportunity to choose a strategy, both actors unfortunately perceive that defection is their best personal option, which ultimately leaves both worse off. The classic version involves two criminal co-conspirators being questioned by police in separate rooms, where each ends up implicating the other since their physical separation prevents them from collaboratively making a mutually beneficial agreement to both stay silent. Yet when the model is extended dynamically over multiple rounds of decision-making instead, a tit-for-tat strategy allows the actors to punish in future rounds those who fail to cooperate.[91] Experiments suggest that tit-for-tat is a very robust strategy in most multi-period negotiations.[92]

By matching the global SCC values already in use in some other countries, the United States could be seen as continuing a tit-for-tat dynamic designed to reinforce those countries' existing commitments and to encourage reciprocal action from additional countries. In fact, for the United States to now depart from this collaborative dynamic by reverting to a domestic-only SCC estimate could undermine long-term U.S. interests in future climate negotiations and could jeopardize emissions reductions underway

89. *See id.*; Richard B. Stewart et al., *Building Blocks for Global Climate Protection*, 32 STAN. ENVTL. L.J. 341, 346 (2013).

90. Kotchen, *supra* note 71, at 18 (referring generally to strategies with punishment schemes and explaining that, in the dynamic setting, a greater set of potential solutions exists than the sub-game perfect Nash equilibrium).

91. *See* ROBERT AXELROD, THE EVOLUTION OF COOPERATION 10–11 (1984) (on repeated prisoner's dilemma games); Peter J. Wood, *Climate Change and Game Theory*, 1219 ANNALS N.Y. ACAD. SCI. 153 (2011).

92. *See* AXELROD, *supra* note 91.

in other countries, which are already benefiting the United States. 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 could 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. If the United States sees the climate negotiations as a repeated dynamic of tit-for-tat, using the global SCC value is a rational strategy.

A related and potentially successful strategy in climate negotiations is to build small, stable coalitions of key actors. Coalitions can then lead by example through joint initial commitments to act. Coalitions also foster communication and trust among nations, and they allow member nations to learn by doing and to apply those lessons in future negotiations with other countries.[93] Moreover, a coalition of major emitters will build critical mass that may tip the scales toward a global agreement. Some evidence exists that the small coalition strategy is more likely to be successful in climate negotiations if nations' initial commitments are close to their actual optimal emissions reductions and are not mere half-measures.[94] By joining other nations in using global SCC values and adopting meaningful greenhouse gas limitations, the United States may be employing a coalition-building strategy. Thus, the United States need not hold out for the promise of immediately inducing complete reciprocity among all countries before it is justified in using the global SCC; using the global SCC now can help build a small coalition of key actors, which will both benefit the United States in the short term and help build toward global agreement. Similarly, after factoring in reasonable predictions on how climate change damages will unfold

93. *See* M. Finus, *Game Theoretic Research on the Design of International Environmental Agreements: Insights, Critical Remarks, and Future Challenges*, 2 INT'L REV. ENVTL. & RESOURCE ECON. 29 (2008); Marco Grasso & Timmons Roberts, *A Compromise to Break the Climate Impasse*, 4 NATURE: CLIMATE CHANGE 543 (2014); E. Ostrom, *A Polycentric Approach for Coping with Climate Change*, 15 ANNALS ECON. & FINANCE 97 (2014); Stewart et al., *supra* note 89.

94. *See* Rory Smead et al., *A Bargaining Game Analysis of International Climate Negotiations*, 4 NATURE: CLIMATE CHANGE 442 (2014) ("If too many players are too far away from their proportional share of reductions, negotiations are likely to break down. Any mechanism that encourages initial demands closer to the target values will increase the likelihood of success.").

in the future, even partial reciprocity can justify using a global SCC estimate.[95]

Applying assumptions more grounded in real-world behavior also makes cooperation more likely. For example, in real negotiations among repeat players and among highly skilled negotiators, negotiators may have even greater foresight with respect to counter-moves than classic models of strategic behavior may predict. One recent article concludes that, applying more realistic assumptions about foresight with respect to counter-moves, every one of the twenty-five possible basic structures that may describe the climate negotiations has at least one cooperative solution.[96] More specifically, theoretical work by economist Matthew Kotchen demonstrates the rationality of individual nations choosing an SCC equal to—or even greater than—the global SCC, under various conditions like repeat and strategic games, and further shows that "all countries have a strategic SCC greater than their domestic SCC."[97]

Experiments also show that real negotiators balance fairness considerations against pure self-interest. In the classic "ultimatum game" experiment, one player is offered a sum of money to split with another player; only if the second player accepts the split will either get any money.[98] Economic theory would predict that a purely rational first player would offer just one cent to the second player, and a purely rational second player would accept the single penny rather than get nothing. In fact, real first players rarely offer anything less than 30% of the money, and real second players rarely accept any split perceived as unfair. Multiple studies find that, regardless of the amount at stake in the ultimatum game, first players from industrialized countries typically offer around a 50%

95. *See* Kopp & Mignone, *supra* note 15, at 11 ("If marginal benefits are declining, however, increasing reciprocity leads the optimal domestic carbon price to approach the global policy SCC concavely, meaning that even imperfect reciprocity can come close to supporting the global policy SCC. . . . The possibility of greater-than-quadratic climate damages and the expectation of weakening carbon sinks can both give rise to declining marginal damages.").

96. Kaveh Madani, *Modeling International Climate Change Negotiations More Responsibly: Can Highly Simplified Game Theory Models Provide Reliable Policy Insights?*, 90 ECOLOGICAL ECON. 68 (2013); *see also* Kotchen, *supra* note 71, at 16 ("[T]he assumption of Nash behavior can also be interpreted as quite arbitrary and perhaps more questionable in the context of international climate policy, where some degree reciprocity among countries is clearly at work.").

97. Kotchen, *supra* note 71, at 4.

98. Wood, *supra* note 91, at 6.

split, and second players frequently reject anything less than a 20% share.[99] This experiment "provides evidence that an international environmental agreement is more likely to be stable if it is perceived by its parties to be fair."[100] By counting the full global damages of its emissions, the United States may be able to improve its reputation for fairness, building the trust and credibility essential to secure reciprocal actions from other countries.

The United States can choose the global SCC as part of a prudent strategy designed to secure international cooperation in a number of different negotiation scenarios—and high-ranking officials in the Obama administration seem to have done precisely that, as detailed in the following section. Conversely, under a wide range of negotiation structures, any departure now by the United States from the global SCC would threaten to undermine long-term U.S. interests in securing continued action by foreign countries and could even jeopardize emissions reductions currently underway in other countries, which are already delivering billions of dollars in benefits to the United States.

E. The Obama and Bush Administrations Believed Using the Global SCC Would Spur Global Cooperation

In a number of pronouncements, from formal administration documents and plans to public speeches and interviews, then-President Obama and officials within his administration declared that the United States would lead international negotiations by example, both by calculating the global costs of its own greenhouse gas emissions and by proposing regulations based in part on the global SCC.

President Obama:

> [M]y goal has been to make sure that the United States can genuinely assert leadership in this [climate] 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

99. *See* Alan G. Sanfey et al., *The Neural Basis of Economic Decision-making in the Ultimatum Game*, 300 SCIENCE 1755 (2003). The ultimatum experiment has been conducted in countries around the world, and though observations of acceptable splits vary by culture, the findings that fairness matters and that unfair splits will frequently be rejected are widespread across cultures and are robust. *See, e.g.*, Hessel Oosterbeek et al., *Cultural Differences in Ultimatum Game Experiments: Evidence from a Meta-Analysis*, 7 EXPERIMENTAL ECON. 171 (2004).

100. Wood, *supra* note 91, at 10 n.18 (citing SCOTT BARRETT, ENVIRONMENT AND STATECRAFT 299–301 (2003)).

> credibility, then it gives us the opportunity to challenge and engage the Chinese and the Indians.[101]

Administration-Wide *Climate Action Plan*:

> The Obama Administration is working to build on the actions that it is taking domestically to achieve significant global greenhouse gas emission reductions and enhance climate preparedness through major international initiatives focused on spurring concrete action.[102]

Administration-Wide Interagency Working Group on the Social Cost of Carbon:

> 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 and in encouraging other nations, including emerging major economies, to take significant steps 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.[103]

Gina McCarthy, Former Administrator, EPA:

> [A domestic value] was considered to be not the most appropriate way to look at it; it's looked at globally.[104]

101. David Remnick, *The Obama Tapes*, NEW YORKER (Jan. 22, 2014), http://www.newyorker.com/news/news-desk/the-obama-tapes [https://perma.cc/86H9-AW79] (quoting an interview with President Obama); *see also* Press Release, White House Office of the Press Sec'y, Remarks by the President in Announcing the Clean Power Plan (Aug. 3, 2015), https://www.whitehouse.gov/the-press-office/2015/08/03/remarks-president-announcing-clean-power-plan [https://perma.cc/UC4F-764V] ("And if we don't do it, nobody will. The only reason that China is now looking at getting serious about its emissions is because they saw that we were going to do it, too."); Pres. Barack Obama, Remarks to League of Conservation Voters (June 25, 2014), https://obamawhitehouse.archives.gov/the-press-office/2014/06/25/remarks-president-league-conservation-voters-capital-dinner [https://perma.cc/ZC75-C46S] ("[W]e've got to lead by example [on climate]. [Other countries are] waiting to see what America does. And I'm convinced when America proves what's possible, other countries are going to come along."); Pres. Barack Obama, Remarks at the U.S. Military Academy Commencement Ceremony (May 28, 2014), https://obamawhitehouse.archives.gov/the-press-office/2014/05/28/remarks-president-united-states-military-academy-commencement-ceremony [https://perma.cc/QR3D-G2KE] ("American influence is always stronger when we lead by example. We can't exempt ourselves from the rules that apply to everyone else. We can't call on others to make commitments to combat climate change if a whole lot of our political leaders deny that it's taking place.").

102. EXEC. OFFICE OF THE PRESIDENT, *supra* note 2, at 17.

103. 2010 TSD, *supra* note 4, at 11.

104. *EPA's Proposed Carbon Pollution Standards for Existing Power Plants: Oversight Hearing Before the Sen. Comm. on Env't & Pub. Works*, 113th Cong. (2014) (testimony of U.S. Envtl.

Jason Furman, Former Chair, Council of Economic Advisors:

> It is entirely appropriate to include those [global benefits] because we're trying to motivate a range of countries all to act together. . . . If everyone did a social cost of carbon for their own country, everyone would have too low a number and everyone would act too little. And it would make everyone, including the U.S., worse off. . . . [The global SCC is] in effect like a proxy for not only looking at the domestic [benefits], taking into account that we'll get benefits not just from the reduced emissions in the U.S. from our rule, but that it will lead to policy changes . . . from other countries.[105]

Michael Greenstone, Former Chief Economist, Council of Economic Advisers:

> The tricky part of carbon reduction is that when we reduce a ton, we benefit China, and when China reduces a ton, they benefit us. It's a classic business deal. If we don't cooperate, we'll all be in a lesser state of the world. Cooperation in this case means accounting for the benefit we are providing for others. If one looks at international negotiations, the U.S. would not be able to show up and have much influence if we came and only talked about domestic damages. We're also asking the world to do things that make us better off. We spent 15 to 20 years trying the other strategy which is, "You guys go first," and I think it's not working. China and India have a pretty good case for not doing that much unless we come with something deliverable. Will we continue to have these rules if we learn that in no state of the world will China cut its emissions? Probably not. Just as in the classic prisoner's dilemma, we'd change our position.[106]

Prot. Agency Adm'r Gina McCarthy); *see also* Laura Barron-Lopez, *EPA Chief: Climate Rule Is About Leadership*, THE HILL (June 16, 2014), http://thehill.com/policy/energy-environment/209487-epa-chief-climate-rule-is-about-leadership [https://perma.cc/L96U-4CCG] (quoting Administrator McCarthy as saying, "This is about leadership. This about [the United States] being a leader on this issue and we believe and we already know it's going to leverage a much better opportunity for a global solution.").

105. John Hendrixson, *White House, EPA Defend Using Global Climate Benefits for GHG Proposal*, INSIDE WASH. PUBLISHERS (Jan. 24, 2017), https://web-beta.archive.org/web/20170125022149/http://iwpnews.com/EPA-Daily-News/Daily-News/feed/rss/menu-id-1046/Page-25.html [https://perma.cc/6ULL-QAAF].

106. G.I., *We Are the World: The Novel Accounting of Greenhouse Gas Regulations*, ECONOMIST FREE EXCHANGE (June 3, 2014), http://www.economist.com/blogs/freeexchange/2014/06/novel-accounting-greenhouse-gas-regulations [https://perma.cc/V2F8-W2HB].

Howard Shelanski, Former Administrator, Office of Information and Regulatory Affairs ("OIRA"):

> [Climate change] is a global problem, and it seems much easier to exercise global leadership and to get other countries around the world to recognize the social costs of carbon if we are doing so ourselves.[107]

John Kerry, Former Secretary of State:

> Lead by example through strong action at home and abroad: Making significant progress in combating climate change through domestic actions within the Department and at the federal, regional, and local level.[108]

Hillary Clinton, Former Secretary of State:

> [P]art of what President Obama is doing [with the proposed regulation on power plant emissions], and I fully support it, is making it clear that the United States is going to act. . . . [W]e are moving but we need to do so much more. . . . [T]he United States cannot go to an international forum unless we've done more.[109]

Todd Stern, Former Special Envoy for Climate Change, Department of State:

> We're in the best standing we've been in in awhile. [Crediting domestic actions like the proposed regulation on power plant emissions with earning the United States improved international standing.][110]

Similarly, the Obama administration tried 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."[111] For example, the

107. *Examining the Obama Administration's Social Cost of Carbon Estimates: Hearing Before the Subcomm. on Energy Policy, Health Care, and Entitlements of the H. Comm. on Oversight and Gov't Reform*, 113th Cong. (2013) (response of OIRA Adm'r Howard Shelanski).

108. Andrew C. Revkin, *Kerry Orders U.S. Diplomats to Press Case for Climate Action*, N.Y. TIMES: DOT EARTH (Mar. 10, 2014), https://dotearth.blogs.nytimes.com/2014/03/10/kerry-orders-u-s-diplomats-to-press-case-for-climate-action [https://perma.cc/8GWS-PS96].

109. Fmr. Sec'y of State Hillary Clinton, Speech at Aspen Ideas Festival, Colo. (June 30, 2014) https://www.aspenideas.org/sites/default/files/images/AIF-Pages/Conversation%20with%20Hillary%20Rodham%20Clinton%20and%20Walter%20Isaacson.pdf [https://perma.cc/S45W-836E].

110. Greg Dalton, *Going to Paris: Ambassador Todd Stern*, CLIMATE ONE (Feb. 18, 2014), http://climateone.org/node/10060 [https://perma.cc/7V3Z-Y3NB].

111. Media Note, Office of the Spokesperson, U.S. Dep't of State, Joint Statement on Climate Change and the Arctic (Aug. 31, 2015), https://2009-2017.state.gov/r/pa/prs/ps/2015/08/246487.htm [https://perma.cc/6UMX-MF75] (made following the GLACIER

United States has highlighted its planned actions on methane in its joint statements on climate with China.[112] 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.

Previously, the George W. Bush administration also made similar determinations on the ability of U.S. action to foster international reciprocity that will return benefits back to the United States. For example, in 2008, EPA's advance notice of proposed rulemaking on carbon reductions acknowledged that "domestic mitigation decisions affect the level of mitigation and emissions changes in general in other countries (i.e., the benefits realized in the U.S. will depend on emissions changes in the U.S. and internationally)."[113] In an associated technical support document, EPA further explained:

> The economic literature on game theory describes this as an "assurance" game . . . . [P]articipation is self-sustaining, as each participant will want to continue to participate over time if others continue to participate. This game theoretic structure can be a useful framework for thinking about . . . potential overall benefits associated with both domestic and potential international actions.[114]

Dealing with the analogously global environmental problem of ozone-depleting substances, the Food and Drug Administration ("FDA") under the George W. Bush administration also noted that the U.S. health gains "could be magnified if other countries follow

conference, at which Canada, Denmark, Finland, Iceland, Norway, Sweden, and Russia were also represented).

112. Press Release, White House Office of the Press Sec'y, U.S.-China Joint Presidential Statement on Climate Change (Sept. 25, 2015), https://obamawhitehouse.archives.gov/the-press-office/2015/09/25/us-china-joint-presidential-statement-climate-change [https://perma.cc/DK33-XZC4].

113. Advanced Notice of Proposed Rulemaking on Regulating Greenhouse Gas Emissions Under the Clean Air Act, 73 Fed. Reg. 44,354, 44,415 (July 30, 2008).

114. U.S. ENVTL. PROT. AGENCY, TECHNICAL SUPPORT DOCUMENT ON BENEFITS OF REDUCING GHG EMISSIONS, at 7 (2008). See also Average Fuel Economy Standards Passenger Cars and Light Trucks Model Year 2011, 74 Fed. Reg. 14,196, 14,349 (Mar. 30, 2009), where NHTSA noted that the current state of "negotiations regarding effective international cooperation" could affect this decision. At the time, the agency felt such considerations necessitated at least some domestic-only estimate, on the assumption that ambitious "unilateral" action by a single country would not be matched by other countries.

suit and further reduce emissions."[115] Importantly, in assessing the benefits of the proposed policy, the FDA considered how, if the United States delayed action on reducing ozone-depleting substances, "other Parties could attempt to delay their own control measures," which would carry "adverse environmental and human health consequences."[116]

In short, the federal government has long recognized, under both Republican and Democratic administrations, that considering the global costs and benefits of actions that affect the Earth's climate systems is a useful strategy to promote U.S. interests in securing international reciprocity. Whether and how the incoming Trump administration will attempt to break from this well-established strategic position remains to be seen. President Trump himself has called climate change a "hoax" that "was created by . . . the Chinese."[117] Scott Pruitt, the new EPA administrator,[118] signed, as Oklahoma's attorney general, the legal brief challenging EPA's use of the global SCC in the Clean Power Plan regulation.[119] A questionnaire sent by the Trump transition team to the current career staff in the Department of Energy probed into their participation in the interagency working group on the SCC.[120] On the other hand, Trump's new Secretary of State, Rex Tillerson,[121] was CEO of ExxonMobil when that company developed its own internal "proxy cost of carbon" of up to $80 per ton by the year 2040—a number consistent with a global estimate.[122] Besides the

115. Use of Ozone-Depleting Substances; Removal of Essential-Use Designations, 69 Fed. Reg. 33,602, 33,612 (June 16, 2004).

116. *Id.* at 33,614; Use of Ozone-Depleting Substances; Removal of Essential-Use Designations, 72 Fed. Reg. 32,030, 32,044 (June 11, 2007).

117. Louis Jacobson, *Yes, Donald Trump Did Call Climate Change a Chinese Hoax*, POLITIFACT (June 3, 2016), http://www.politifact.com/truth-o-meter/statements/2016/jun/03/hillary-clinton/yes-donald-trump-did-call-climate-change-chinese-h/ [https://perma.cc/4BY7-8QNP].

118. Coral Davenport, *Senate Confirms Pruitt as E.P.A. Head*, N.Y. TIMES (Feb. 17, 2017), https://www.nytimes.com/2017/02/17/us/politics/scott-pruitt-environmental-protection-agency.html?_r=0 [https://perma.cc/VDX8-8M8G].

119. *See* Brief for Petitioners, *supra* note 13, at 70.

120. Hannah Northey, *Trump Team Steps Back from Questionnaire, but Dems Still Wary*, E & E NEWS (Dec. 14, 2016), http://www.eenews.net/eenewspm/stories/1060047212/feed [https://perma.cc/69FF-NQBQ].

121. Gardiner Harris, *Rex Tillerson Is Confirmed as Secretary of State Amid Record Opposition*, N.Y. TIMES (Feb. 1, 2017), https://www.nytimes.com/2017/02/01/us/politics/rex-tillerson-secretary-of-state-confirmed.html [https://perma.cc/8YK9-8QLZ].

122. Letter from ExxonMobil to U.S. Sec. & Exch. Comm'n (Jan. 22, 2016), https://www.sec.gov/divisions/corpfin/cf-noaction/14a-8/2016/nystatecommon012216-14a8-incoming.pdf [https://perma.cc/QU3Y-RDHH].

crucial strategic considerations explored in this section, additional policy justifications and legal requirements will constrain attempts by the Trump administration to deregulate greenhouse gas emissions while ignoring the globally interconnected costs of climate change.

IV. ADDITIONAL POLICY JUSTIFICATIONS FOR THE GLOBAL SCC

International reciprocity provides the strongest policy justification for a global valuation of greenhouse gases, but additional arguments should also push federal agencies to look beyond domestic-only effects, including the inevitability of significant spillover effects, U.S. responsibility for the global commons of the oceans and Antarctica, U.S. interests in conducting business and travel abroad, U.S. citizens living or owning property abroad, and the altruistic willingness of U.S. citizens to pay to protect some foreign welfare. For these reasons, emphasizing a domestic-only SCC or SCM would fail to disclose the true scope of climate-related costs and benefits that matter to U.S. policymakers and the public. Moreover, even the global SCC contains some biases that give greater weight to U.S. effects; explicitly reverting to a domestic-only SCC would compound that bias.

A. Inevitably Significant "Spillover" Effects Justify a Broader Perspective

In 2010, the interagency working group used the results of one economic model as well as the U.S. share of global GDP to generate an "approximate, provisional, and highly speculative" range of 7–23% of the global SCC as an estimate of the purely direct climate effects to the United States.[123] Yet, as the interagency group acknowledged, this range is almost certainly an underestimate because it ignores significant, indirect costs to trade, human health, and security likely to "spill over" to the United States as other regions experience climate change damages.[124]

123. *See* 2010 TSD, *supra* note 4, at 11.

124. *Id.* Indeed, the integrated assessment models used to develop the global SCC estimates largely ignore interregional costs. *See* HOWARD, *supra* note 47. Though some positive spillover effects are also possible, such as technology spillovers that reduce the cost of mitigation or adaptation, *see* S. Rao et al., *Importance of Technological Change and Spillovers in*

The United States is not an island, contrary to the assumptions underlying the economic models used to calculate the SCC, which treat regions as isolated. Due to its unique place among countries—both as the largest economy with trade- and investment-dependent links throughout the world, and as a military superpower—the United States is particularly vulnerable to effects that will spill over from other regions of the world. Spillover scenarios could entail a variety of serious costs to the United States as unchecked climate change devastates other countries. Correspondingly, mitigation or adaptation efforts that avoid climate damages to foreign countries will radiate benefits back to the United States as well.[125]

As climate change disrupts the economies of other countries, decreased availability of imported inputs, intermediary goods, and consumption goods may cause supply shocks to the U.S. economy. Shocks to the supply of energy, technological, and agricultural goods could be especially damaging. For example, when Thailand—the world's second-largest producer of hard drives—experienced flooding in 2011, U.S. consumers faced higher prices for many electronic goods, from computers to cameras.[126] A recent economic study explored how heat stress-induced reductions in productivity worldwide will ripple through the interconnected global supply network.[127] Similarly, the U.S. economy could experience demand shocks as climate-affected countries decrease their demand for U.S. goods. Financial markets may also suffer as foreign countries become less able to loan money to the United States and as the value of U.S. firms declines with shrinking foreign profits. As seen historically, economic disruptions in one country can cause financial crises that reverberate globally at a breakneck pace.[128]

Long-Term Climate Policy, 27 ENERGY J. 123–39 (2006), overall spillovers likely mean that the U.S. share of the global SCC is underestimated, *see* Freeman & Guzman, *supra* note 50.

125. *See* Freeman & Guzman, *supra* note 50, at 1563–93.

126. *See* Charles Arthur, *Thailand's Devastating Floods Are Hitting PC Hard Drive Supplies*, THE GUARDIAN (Oct. 25, 2011), https://www.theguardian.com/technology/2011/oct/25/thailand-floods-hard-drive-shortage [https://perma.cc/4MV8-554N].

127. Leonie Wenz & Anders Levermann, *Enhanced Economic Connectivity to Foster Heat Stress-Related Losses*, SCI. ADVANCES (June 10, 2016), http://advances.sciencemag.org/content/2/6/e1501026 [https://perma.cc/63Y9-JL5M].

128. *See* 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).

The human dimension of climate spillovers includes migration and health effects. Water and food scarcity, flooding or extreme weather events, violent conflicts, economic collapses, and a number of other climate damages could precipitate mass migration to the United States from regions worldwide, especially, perhaps, from Latin America. For example, a 10% decline in crop yields could trigger the emigration of 2% of the entire Mexican population to other regions, mostly to the United States.[129] Such an influx could strain the U.S. economy and will likely lead to increased U.S. expenditures on migration prevention. Infectious disease could also spill across the U.S. borders, exacerbated by ecological collapses, the breakdown of public infrastructure in poorer nations, declining resources available for prevention, shifting habitats for disease vectors, and mass migration.

Finally, climate change is predicted to exacerbate existing security threats—and possibly catalyze new security threats—to the United States.[130] Besides threats to U.S. military installations and operations abroad from flooding, storms, extreme heat, and wildfires,[131] President Obama explained how climate change is "a creeping national security crisis, . . . as [the U.S. military will be] called on to respond to refugee flows and natural disasters, and conflicts over water and food."[132] The Department of Defense's 2014 Defense Review declared that climate effects "are threat multipliers that will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions—conditions that can enable terrorist activity and other forms of violence," and as a result "climate change may increase the frequency, scale, and complexity of future missions, including defense support to civil authorities, while at the same time undermining the capacity of our domestic installations to support training activities."[133] As an example of the climate-security-migration nexus, prolonged drought in Syria likely exacerbated the

129. Shuaizhang Feng et al., *Linkages Among Climate Change, Crop Yields and Mexico-U.S. Cross-Border Migration*, 107 PROC. NAT'L ACAD. SCI. 14,257 (2010).

130. *See generally* CNA MILITARY ADVISORY BD., NATIONAL SECURITY AND THE ACCELERATING RISKS OF CLIMATE CHANGE (2014).

131. U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-14-446, CLIMATE CHANGE ADAPTATION: DOD CAN IMPROVE INFRASTRUCTURE PLANNING AND PROCESSES TO BETTER ACCOUNT FOR POTENTIAL IMPACTS (2014).

132. Pres. Barack Obama, Commencement Address, U.S. Military Academy at West Point, N.Y. (May 28, 2014).

133. U.S. DEP'T OF DEF., QUADRENNIAL DEFENSE REVIEW 2014, at vi (2014).

social and political tensions that erupted into an ongoing civil war,[134] which has triggered an international migration and humanitarian crisis.[135]

Because of these interconnections, attempts to artificially segregate a U.S.-only portion of climate damages will inevitably result in misleading underestimates. Some experts on the social cost of carbon have concluded that, given that integrated assessment models currently do not capture many of these key interregional costs, use of the global SCC may be further justified as a proxy to capturing all spillover effects.[136] Though surely not all climate damages will spill back to affect the United States, many will, and together with other justifications, the likelihood of significant spillovers makes a global valuation the better, more transparent accounting of the full range of costs and benefits that matter to U.S. policymakers and the public.

B. U.S. Willingness to Pay to Prevent Climate Damages Beyond U.S. Borders

Estimates of costs and benefits in regulatory impact analyses, including the social cost of carbon and methane metrics, are fundamentally willingness-to-pay estimates. The willingness-to-pay framework places values on benefits "by measuring what individuals are willing to forgo to enjoy a particular benefit."[137] The climate-sensitive things that U.S. citizens are willing to pay for, however, do not fall neatly within our own geographic borders. A domestic-only SCC based on some rigid conception of geographic borders or U.S.

134. *See* Peter H. Gleick, *Water, Drought, Climate Change, and Conflict in Syria*, 6 WEATHER, CLIMATE & SOC'Y, 331 (2014); Colin P. Kelley et al., *Climate Change in the Fertile Crescent and Implications of the Recent Syrian Drought*, 112 PROC. NAT'L ACAD. SCI. 3241 (2014); Caitlin E. Werrell et al., *The Arab Spring and Climate Change: A Climate and Security Correlations Series*, CTR. FOR AM. PROGRESS (Feb. 28, 2013), https://www.americanprogress.org/issues/security/reports/2013/02/28/54579/the-arab-spring-and-climate-change [https://perma.cc/MUM3-B3K3].

135. *See, e.g.*, *Ending Syria War Key to Migrant Crisis, Says U.S. General*, BBC (Sept. 14, 2015), http://www.bbc.com/news/world-middle-east-34240707 [https://perma.cc/RQW9-QJVR].

136. *See* Kopp & Mignone, *supra* note 15, at 833.

137. Office of Mgmt. & Budget, *Circular A-4*, NAT'L ARCHIVES (Sept. 17, 2003), https://georgewbush-whitehouse.archives.gov/omb/circulars/a004/a-4.html [https://perma.cc/GSV8-TAUR].

share of world GDP will consequently fail to capture all the climate-related costs and benefits that matter to U.S. citizens.[138]

U.S. citizens have economic and other interests abroad that are not fully reflected in the U.S. share of global GDP. GDP is a "monetary value of final goods and services—that is, those that are bought by the final user—produced in a country in a given period of time."[139] GDP therefore may not reflect significant U.S. ownership interests in foreign businesses, properties, and other assets, as well as consumption abroad including tourism and eco-tourism,[140] and even the approximately eight million Americans living abroad.[141] At the same time, GDP is also over-inclusive, counting productive operations in the United States that are owned by foreigners. Gross National Income ("GNI"), by contrast, defines its scope not by location but by ownership interests.[142] However, not only has GNI fallen out of favor as a metric used in international economic policy, but using a domestic-only SCC based on GNI would make the SCC metrics incommensurable with other costs in regulatory impact analyses, since most regulatory costs are calculated by U.S. agencies regardless of whether they fall to U.S.-owned entities or to foreign-owned entities operating in the

138. A domestic-only SCC would fail to "provide to the public and to [the Office of Management and Budget] a careful and transparent analysis of the anticipated consequences of economically significant regulatory actions." OFFICE OF INFO. & REGULATORY AFFAIRS, REGULATORY IMPACT ANALYSIS: A PRIMER, at 2 (2011).

139. Tim Callen, *Gross Domestic Product: An Economy's All*, INT'L MONETARY FUND, http://www.imf.org/external/pubs/ft/fandd/basics/gdp.htm [https://perma.cc/72BC-NNXD] (last updated Mar. 28, 2012).

140. "U.S. residents spend millions each year on foreign travel, including travel to places that are at substantial risk from climate change, such as European cities like Venice and tropical destinations like the Caribbean islands." David A. Dana, *Valuing Foreign Lives and Civilizations in Cost-Benefit Analysis: The Case of the United States and Climate Change Policy* (Nw. Univ. Sch. of Law, Faculty Working Paper No. 196, 2009), http://scholarlycommons.law.northwestern.edu/cgi/viewcontent.cgi?article=1195&context=facultyworkingpapers [https://perma.cc/SV7D-PD9A].

141. ASS'N AMS. RESIDENT OVERSEAS, https://www.aaro.org/about-aaro/6m-americans-abroad [https://perma.cc/P3SM-SFWP]. Admittedly eight million is only 0.1% of the total population living outside the United States.

142. *Gross National Income*, INVESTOPEDIA, http://www.investopedia.com/terms/g/gross-national-income-gni.asp [https://perma.cc/2Q42-HWM9] (last visited Feb. 17. 2017); *see also GNI, Atlas Method (Current US$)*, WORLD BANK, http://data.worldbank.org/indicator/NY.GNP.ATLS.CD [https://perma.cc/K8R2-3DYF] (last visited Jan. 22, 2017).

United States.[143] The artificial constraints of both metrics counsel against a rigid split based on either U.S. GDP or U.S. GNI.[144]

The United States also has some willingness to pay—as well as perhaps a legal obligation—to protect the global commons of the oceans and Antarctica from climate damages. For example, the Madrid Protocol on Environmental Protection to the Antarctic Treaty commits the United States and other parties to the "comprehensive protection of the Antarctic environment," including "regular and effective monitoring" of "effects of activities carried on both within and outside the Antarctic Treaty area on the Antarctic environment."[145] The share of climate damages for which the United States is responsible is not limited to our geographic borders.

Similarly, U.S. citizens value natural resources and plant and animal lives abroad, even if they never use those resources or see those plants or animals. For example, the "existence value" of restoring the Prince William Sound after the 1989 Exxon Valdez oil tanker disaster—that is, the benefits derived by Americans who would never visit Alaska but nevertheless felt strongly about preserving the existence of this pristine environment—was estimated in the billions of dollars.[146] Though the methodologies for calculating existence value remain controversial,[147] U.S. citizens certainly have a non-zero willingness to pay to protect rainforests, charismatic megafauna like pandas, and other life and environments existing in foreign countries. U.S. citizens also have a non-zero, altruistic willingness to pay to protect foreign citizens' health and welfare,[148] which—together with the other justifications

143. U.S. OFFICE OF MGMT & BUDGET & SECRETARIAT GEN. OF THE EUROPEAN COMM'N, *supra* note 6, at 13.

144. Advanced Notice of Proposed Rulemaking on Regulating Greenhouse Gas Emissions Under the Clean Air Act, 73 Fed. Reg. 44,354, 44,415 (July 30, 2008) ("Furthermore, international effects of climate change may also affect domestic benefits directly and indirectly to the extent U.S. citizens value international impacts (e.g., for tourism reasons, concerns for the existence of ecosystems, and/or concern for others); U.S. international interests are affected (e.g., risks to U.S. national security, or the U.S. economy from potential disruptions in other nations).").

145. *See generally* Protocol on Environmental Protection to the Antarctic Treaty, Oct. 4, 1991, 30 I.L.M. 1455 (entered into force Jan. 14, 1998).

146. RICHARD L. REVESZ & MICHAEL A. LIVERMORE, RETAKING RATIONALITY: HOW COST-BENEFIT ANALYSIS CAN BETTER PROTECT THE ENVIRONMENT AND OUR HEALTH 121 (2008).

147. *Id.* at 129.

148. *See* Arden Rowell, *Foreign Impacts and Climate Change*, 39 HARV. ENVTL. L. REV. 371 (2015); Dana, *supra* note 140 (discussing U.S. charitable giving abroad and foreign aid, and

detailed in this report—provides further support strongly in favor of global SCC and SCM metrics.

C. Lack of Equity Weights Already Favors U.S. Interests

Finally, the methodologies for the global SCC and global SCM currently discount foreign welfare to some extent, and thus are arguably already somewhat biased toward a U.S.-centered perspective. Given decreasing marginal utility of consumption and heterogeneity in regional wealth, a dollar lost has heterogeneous welfare effects across regions. For example, the social cost of carbon reflects monetized values of preventing mortality risks that vary with the per capita income of the country where the risk would occur, because the methodologies estimate how much foreign persons are willing to pay themselves to avert risks to themselves.[149] As a result, the social cost of carbon values eliminating a ten-in-a-million risk of death affecting a million people at $90 million if those people live in the United States, at $40 million if they live in Canada, and at only $0.9 million if they live in India.[150] Therefore, some modelers have proposed applying equity weights (i.e., weighting the dollar loss in each region by the expected welfare impact it will have in this region) in the utility calculation of the SCC to accurately measure the change in the expected value of social welfare from emissions.[151] Nevertheless, the interagency working group on the social cost of carbon rejected equity weighting.[152] Consequently, current calculations of the SCC and

how those metrics likely severely underestimate true U.S. willingness to pay to protect foreign welfare).

149. Rowell, *supra* note 148, at 388.

150. *Id.*

151. *See, e.g.*, David Anthoff et al., *Equity Weighting and the Marginal Damage Costs of Climate Change*, 68 ECOLOGICAL ECON. 836 (2009) (noting that the equity-weighted SCC measures impacts in welfare terms normalized to some common currency, and recommending the use of current U.S. dollars as the appropriate base for cost-benefit analysis within the United States). The non-equity-weighted SCC measures impacts in pure dollar terms (i.e., independent of the location of the impact), such that these impacts have differing welfare effects based on the recipients' initial wealth. *Id.*

152. The 2010 TSD states:

> When quantifying the damages associated with a change in emissions, a number of analysts (e.g., Anthoff, et al. 2009a) employ "equity weighting" to aggregate changes in consumption across regions. This weighting takes into account the relative reductions in wealth in different regions of the world. A per capita loss of $500 in GDP, for instance, is weighted more heavily in a country with a per-capita GDP of $2,000 than in one with a per-capita GDP of $40,000. The main argument for this approach is that a loss of $500 in a poor country causes a greater reduction in utility or welfare than does

SCM already place relatively greater weight on domestic climate impacts, because they fail to apply equity weights to impacts experienced by foreign countries with lower GDP per capita. Any further weighting or emphasis of domestic impacts would, therefore, be theoretically and morally questionable.

V. BINDING LEGAL OBLIGATIONS PRESCRIBE USING A GLOBAL SCC VALUE

The United States has already signed and ratified one international treaty that commits it to the consideration of global climate effects of its domestic actions. Two key statutes for U.S. climate policy—the Clean Air Act and NEPA—do the same, and it is reasonable for agencies to consider global climate effects under the other statutes most used to date for climate regulation. Though the Trump administration is anticipated to try to break from President Obama's efforts to combat climate change, legal standards for rational decision-making could constrain attempts to deregulate greenhouse gas emissions while ignoring globally interconnected climate damages.

A. International Law Commits the United States to Account for Global Effects

Binding international agreements 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."[153] The Convention further commits parties to evaluating global

> the same loss in a wealthy nation. Notwithstanding the theoretical claims on behalf of equity weighting, the interagency group concluded that this approach would not be appropriate for estimating a SCC value used in domestic regulatory analysis. For this reason, the group concluded that using the global (rather than domestic) value, without equity weighting, is the appropriate approach.

2010 TSD, *supra* note 4, at 11.

153. U.N. Framework Convention on Climate Change art. 3(3), May 9, 1992, 1771 U.N.T.S. 107 (emphasis added); *see also id.* art. 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.* art. 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").

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."[154] 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 regulatory impact assessments. In 2008, a group of U.S. senators—including Senator John Kerry, who helped ratify the framework convention on climate change—agreed with this interpretation of the treaty language, saying that "[u]pon signing this treaty, the United States committed itself to considering the global impacts of its greenhouse gas emissions."[155] The Trump administration is considering withdrawing the United States from the Convention.[156]

The Convention reflects a basic ethical responsibility to prevent transboundary environmental harms that has been enshrined in customary international law.[157] 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. Indeed, taking a

154. *Id.* art. 4(1)(f) (emphasis added); *see also id.* art. 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 art. 10(7), Jan. 1, 1994, 32 I.L.M. 1480 (committing the United States to the development of principles for transboundary environmental impact assessments).

155. Comment Letter from U.S. Sens. Feinstein, Snowe, Nelson, Cantwell, Sanders, Kerry, Durbin, Reed, Boxer, & Cardin to Mary Peters, Sec'y, U.S. Dep't of Transp. on Proposed Rule for Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011–2015 (July 1, 2008).

156. Valerie Volcovici & Alister Doyle, *Trump Is Reportedly Looking for the Quickest Way Out of the Climate Deal*, FORTUNE (Nov. 14, 2016), http://fortune.com/2016/11/14/donald-trump-paris-climate-change-deal [https://perma.cc/J9CT-FLCK].

157. *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," and that "there can be no questions but that Principle 21 [of the Stockholm Declaration on the Human Environment] reflects a rule of customary international law").

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.[158]

B. Two Key Statutes Require Consideration of Global Climate Costs

Many of the most important climate regulations issued to date have been developed by EPA under the authority of the Clean Air Act. Clean Air Act regulations make up nearly a third of all regulatory proceedings that have used the SCC or SCM.[159] Environmental impact statements required under NEPA have recently begun to feature use of the SCC and SCM.[160] Both statutes to some degree require agencies to consider the global effects of U.S. greenhouse gas emissions.

The Clean Air Act is arguably the most important statute for U.S. climate policy. In 2007, the Supreme Court ruled that greenhouse gases were "pollutants" under the Act.[161] Since then, EPA has regulated greenhouse gases from cars, trucks, power plants, and other sources under sections 111 and 202 of the Act, and under its "prevention of significant deterioration" program. All three of those provisions charge EPA with protecting the public "welfare,"[162] where "welfare" is defined to include "effects on . . . weather . . . and climate."[163] When interpreting section 202, the Supreme Court found "there is nothing counterintuitive to the notion that EPA can curtail the emission of substances that are putting the *global* climate out of kilter."[164] When industry challenged another EPA climate program by arguing that the Clean Air Act "was concerned about local, not global effects," the U.S. Court of Appeals for the D.C. Circuit had "little trouble disposing of Industry Petitioners' argument that the [Clean Air Act's prevention of significant deterioration] program is specifically focused solely on localized air pollution," finding instead that the statute was

158. *See* Paul Baer & Ambuj Sagar, *Ethics, Rights and Responsibilities*, *in* CLIMATE CHANGE SCIENCE & POLICY 262–69 (Stephen Schneider et al. eds., 2009).

159. *See infra* Appendix A.

160. *Id.*

161. Massachusetts v. EPA, 549 U.S. 497 (2007).

162. *E.g.*, 42 U.S.C. §§ 7411, 7470, 7521 (2012).

163. *Id.* § 7602(h); *Massachusetts*, 549 U.S. at 506.

164. *Massachusetts*, 549 U.S. at 531 (emphasis added).

"meant to address a much broader range of harms," including "precisely the types of harms caused by greenhouse gases."[165]

Moreover, since 1965, the Act has explicitly provided for the consideration of how U.S. air pollution affects global health and welfare. The 1965 House of Representatives report on amendments to the Clean Air Act declared that the "United States cannot in good conscience decline to protect its neighbors from pollution which is beyond their legal control," and the Senate report explained that "[i]t is important that we, in the interest of international amity and in fairness to the people of other countries, afford them the benefits of protective measures."[166] Congress recognized that international cooperation would yield "reciprocal benefits" for the United States.[167] Congress was clearly motivated by the desire to both fulfill ethical duties and advance international relations, and so charged EPA with taking a global perspective on air emissions.

The current version of the Clean Air Act's international air pollution provision comes at section 115. That section directs EPA and the states to mitigate U.S. emissions that endanger the foreign health and welfare of countries that have granted the United States some reciprocal rights.[168] Though section 115 has not yet been invoked by EPA as authority for its climate regulations, there is a strong legal case that section 115's triggers have been satisfied, thus requiring the United States to take a global perspective on the effects of its greenhouse gas emissions.[169] The global perspective explicitly incorporated into section 115 should be read to permeate the entire Clean Air Act. For example, if EPA's climate regulations under other parts of the Clean Air Act fail to control adequately the endangerment to foreign health and welfare, then section 115 can be invoked. The global perspective on climate costs and benefits explicitly required by section 115 therefore should inform

165. Coal. for Responsible Regulation v. EPA, 684 F.3d 102, 135, 138 (D.C. Cir. 2012).

166. H.R. REP. NO. 89-899, at 5 (1965); S. REP. NO. 89-192, at 6 (1965).

167. S. REP. NO. 89-192, at 6.

168. 42 U.S.C. § 7415.

169. Michael Burger et al., *Legal Pathways to Reducing Greenhouse Gas Emissions Under Section 115 of the Clean Air Act*, 28 GEO. ENVTL. L. REV. 359 (2016); Petition from Michael Livermore et al., Inst. for Pol'y Integrity, to Bob Perciasepe, Acting Adm'r, U.S. Envtl. Prot. Agency, 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), http://policyintegrity.org/documents/Policy%20Integrity%20Omnibus%20GHG%20Petition%20under%20CAA.pdf [https://perma.cc/P22T-B8VG].

all regulatory actions developed under any section of the Clean Air Act.[170]

As a brief but noteworthy aside, the Clean Air Act's sister statute, the Clean Water Act, contains a similar provision focused on international reciprocity.[171] Though the Clean Water Act has not yet been used directly to regulate greenhouse gas emissions, at least two Clean Water Act regulations of the energy sector indirectly affected greenhouse gas emissions, and the global social cost of carbon was used in the accompanying regulatory impact analyses.[172] Given climate change's impacts on sea-level rise as well as carbon dioxide-induced ocean acidification, this Clean Water Act provision could conceivably become a future source of authority for taking a global perspective on climate regulations.

NEPA further supports interpreting agencies' statutory authorities to require a global perspective on costs and benefits. Enacted in 1970, NEPA states in a provision on "International and National Coordination of Efforts" that "all agencies of the Federal Government *shall* . . . recognize the worldwide and long-range character of environmental problems."[173] Using a global SCC and SCM to analyze and set policy fulfills 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."[174] By continuing

170. *See* Nathan Richardson, *EPA and Global Carbon: Unnecessary Risk*, COMMON RESOURCES (Feb. 28, 2013), http://www.rff.org/blog/2013/epa-and-global-carbon-unnecessary-risk [https://perma.cc/6AKU-GF4N] (explaining how section 115 authorizes use of a global SCC value when regulating under other Clean Air Act provisions).

171. 33 U.S.C. § 1320 (2012).

172. *See infra* Appendix A.

173. 42 U.S.C. § 4332(2)(f) (2012) (emphasis added).

174. *Id.*; *see also* Envtl. Def. Fund v. Massey, 986 F.2d 528, 535 (D.C. Cir. 1993) (confirming that subsection (f) is mandatory); Nat. Res. Def. Council, Inc. v. Nuclear Regulatory Comm'n, 647 F.2d 1345, 1357 (D.C. Cir. 1981) ("This NEPA prescription, I find, looks toward cooperation, not unilateral action, in a manner consistent with our foreign policy."); *cf.* COUNCIL ON ENVTL. QUALITY, GUIDANCE ON NEPA ANALYSIS FOR TRANSBOUNDARY IMPACTS (1997); COUNCIL ON ENVTL. QUALITY, DRAFT NEPA GUIDANCE ON CONSIDERATION OF THE EFFECTS OF CLIMATE CHANGE AND GREENHOUSE GAS EMISSIONS, at 2 (2010) (defining climate change as a "global problem"); Exec. Order No. 12,114, 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").

to use the global SCC and SCM to spur reciprocal foreign actions, federal agencies "lend appropriate support" to NEPA's goal of "maximize[ing] international cooperation" to protect "mankind's world environment."[175]

In addition to these general pronouncements on international and interagency coordination, NEPA requires agencies to prepare environmental impact statements for major actions with significant environmental consequences. The Council on Environmental Quality is charged with developing guidance for agencies on their environmental impact statements. In guidance, the Council has approved the use of the interagency working group's estimate of the social cost of carbon—an estimate of global damages—in any economic analyses included as part of agencies' environmental impact statements.[176]

C. Considering Global Climate Costs Under Other Key Statutes Is Reasonable

Energy efficiency is a powerful method of reducing greenhouse gas emissions. A majority of regulatory actions that use the SCC or SCM have been energy efficiency standards issued under energy policy laws, especially the Energy Policy and Conservation Act as modified by the Energy Independence and Security Act of 2007.[177] The Department of Energy ("DOE") is charged with prescribing energy conservation standards for a wide range of consumer products and industrial equipment (besides cars, for which the Department of Transportation prescribes fuel efficiency standards). Under these statutes, the Department of Energy prescribes "the maximum improvement in energy efficiency . . . [that] is technologically feasible and economically justified."[178] To determine what is "economically justified," the agency measures "whether the benefits of the standard exceed its burdens," after considering "the need for national energy . . . conservation."[179]

175. 42 U.S.C. § 4332(2)(f).

176. *See* COUNCIL ON ENVTL. QUALITY, *supra* note 62.

177. *See supra* Chart 1.

178. *See, e.g.*, 42 U.S.C. § 6295(o)(2)(A).

179. *Id.* § 6295(o)(2)(B)(i). The DOE also may consider any "other factors the Secretary considers relevant." *Id.*; *see also, e.g.*, Energy Conservation Program: Energy Conservation Standards for Walk-In Coolers and Freezers, 78 Fed. Reg. 55,782, 55,788 (proposed Sept. 11, 2013) (defining the phrase "technologically feasible and economically justified" under § 6313 by citing the factors listed under § 6295(o)(2)(B), and considering the global SCC in its regulatory analysis).

The key statutory term "need" is not defined,[180] and the agency may interpret such ambiguous language, subject to the constraints of rationality.[181] Since at least President George H.W. Bush's administration in 1989, the Department of Energy has considered "environmental effects," including the "national security" implications of "mitigating global warming and pollution," as part of the "economic justification" for efficiency standards, under the "need of the nation to conserve energy" prong.[182] Since at least 1991, the agency has "quantified"—"to the extent DOE had data"—the "social benefits" of preventing environmental damages like "global warming" not only to help justify the standards already selected, but additionally to factor into "the development of the selected standard levels."[183]

It is clearly reasonable for the Department of Energy to determine that part of the need for national energy conservation is to encourage reciprocal international commitments that will directly benefit the United States, to protect the United States from spillover effects from foreign countries, and to safeguard the interests of U.S. citizens beyond our borders. Certainly the statute nowhere bars the consideration of the global consequences of energy efficiency regulation. Given that economically efficient climate policies can result only if all countries consider the global externalities of their greenhouse gas emissions, the Department of Energy can consider the global SCC and global SCM as part of the need for national energy conservation. The U.S. Court of Appeals for the Seventh Circuit recently ruled that it had "no doubt" that the "need for conservation" prong authorizes the Department of Energy to consider the SCC, and further found that use of the global SCC was "reasonabl[e]."[184]

180. *See* 42 U.S.C. § 6291.

181. *See* Chevron, U.S.A., Inc. v. Nat. Res. Def. Council, Inc., 467 U.S. 837, 842–45 (1984).

182. Energy Conservation Program for Consumer Products, 54 Fed. Reg. 47,916, 47,924, 47,937, 47,940 (Nov. 17, 1989) (agreeing with commenters).

183. Energy Conservation Program for Consumer Products, 56 Fed. Reg. 22,250, 22,259 (May 14, 1991) (again at the behest of commenters).

184. Zero Zone, Inc. v. Dep't of Energy, 832 F.3d 654, 677, 679 (7th Cir. 2016); *see also id.* at 677 ("To determine whether an energy conservation measure is appropriate under a cost-benefit analysis, the expected reduction in environmental costs *needs* to be taken into account.") (emphasis added). In addition to the "need for conservation" prong, the court also concluded that the agency "probably" had authority to consider environmental benefits under two other prongs of the "economically justified" test (i.e., economic impact on consumers, and "other factors"). *Id.* at 677 n.24. In our role as staff for the Institute for

Similarly, the energy policy statutes give the Department of Transportation nearly identical instructions to weigh "the need of the United States to conserve energy" in setting motor vehicle efficiency standards.[185] In defining that language, the agency has explained:

> As courts of appeal have noted in three decisions stretching over the last 20 years, [the Department of Transportation] defined the "need of the Nation to conserve energy" in the late 1970s as including ". . . environmental, and foreign policy implications . . . ." In 1988, [the agency] included climate change concepts in its [vehicle efficiency standards] . . . . Since then, [the agency] has considered the benefits of reducing tailpipe carbon dioxide emissions . . . pursuant to the statutory requirement to consider the nation's need to conserve energy by reducing fuel consumption.[186]

In 1988, the U.S. Court of Appeals for the D.C. Circuit highlighted that the Energy Policy and Conservation Act contains no statutory command prohibiting environmental considerations.[187] The court further approved of the Department of Transportation's interpretation that the reference to "need of the Nation to conserve energy" "*requires* consideration of . . . environmental . . . implications."[188] More recently, in 2008, the U.S. Court of Appeals for the Ninth Circuit indicated that, due to advancements in "scientific knowledge of climate change and its causes," "[t]he need of the nation to conserve energy is even more pressing today than it was at the time of EPCA's enactment."[189] The court held that the Department of Transportation's failure to monetize climate benefits explicitly in its economic assessment of vehicle efficiency standards was arbitrary and capricious.[190] In that ruling, the court listed several estimates of the global SCC as values

Policy Integrity, the authors helped prepare an amicus brief that "highlighted" these SCC issues for the court. *Id.* at 677 n.23.

185. 49 U.S.C. § 32,902(f).

186. 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624, 62,669–70 (Oct. 15, 2012).

187. Pub. Citizen v. Nat'l Highway Traffic Safety Admin., 848 F.2d 256 (D.C. Cir. 1988).

188. *Id.* at 263 n.27 (adding emphasis to the word "requires," and explaining that EPCA contains no statutory command prohibiting environmental considerations) (quoting 42 Fed. Reg. 63,184, 63,188 (Dec. 15, 1977)).

189. Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1197–98 (9th Cir. 2008).

190. *Id.* at 1203.

that the agency could have chosen.[191] In short, it is not only reasonable for agencies to consider global climate effects under the Energy Policy and Conservation Act, but under certain circumstances it may be required.

The Department of the Interior ("DOI") has only recently begun regulating greenhouse gas emissions from federal leases of energy resources. In prescribing methane venting and flaring limits for oil and gas operations on public land, DOI's Bureau of Land Management weighed the social costs of methane and carbon.[192] Neither the Mineral Leasing Act nor the Federal Land Policy and Management Act contains any language that would prohibit the Bureau's consideration of the full climate effects of its proposed regulations. The Federal Land Policy and Management Act, for example, instructs the Department of the Interior to "manage the public lands under principles of multiple use and sustainable yield."[193] "Multiple use" is defined as

> the management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people; . . . a combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources, including, but not limited to . . . the quality of the environment.[194]

The Act's "congressional declaration of policy" elaborates that the goal is to manage public lands "in a manner that will protect the quality of scientific, scenic, historical, ecological, *environmental, air and atmospheric*, water resource, and archeological values."[195] Congress clearly intended the agency to consider a full range of environmental factors in setting its land management policies.[196]

191. *Id.* at 1199.

192. BUREAU OF LAND MGMT., DOI-BLM-WO-WO2100-2017-0001-EA, ENVIRONMENTAL ASSESSMENT: WASTE PREVENTION, PRODUCTION SUBJECT TO ROYALTIES, AND RESOURCE CONSERVATION (2016).

193. 43 U.S.C. § 1732(a) (2012).

194. *Id.* § 1702(c).

195. *Id.* § 1701(a)(8) (emphasis added); *see also id.* § 1701(a)(7) (referencing the goal of multiple use).

196. *See, e.g.*, JAYNI FOLEY HEIN, INST. FOR POL'Y INTEGRITY, HARMONIZING PRESERVATION AND PRODUCTION: HOW MODERNIZING THE DEPARTMENT OF THE INTERIOR'S FISCAL TERMS FOR OIL, GAS, AND COAL LEASES CAN ENSURE A FAIR RETURN TO THE AMERICAN PUBLIC, at 4–5 (2015).

Importantly, the Act's reference to the "future needs of the American people" does not limit the Department of the Interior to a domestic-only approach to the social costs of methane or carbon. Rather, much like under the energy policy statutes, "need" is undefined and left to the agency's reasonable interpretation. Just as the Departments of Energy and Transportation may interpret "need" to include the strategy of securing reciprocal international action that will benefit the United States, so too may the Department of the Interior consider the global climate consequences of its action in an effort to safeguard the need of future Americans who will benefit from international coordination on climate.

The energy policy statutes and land management statutes, therefore, can all be reasonably interpreted to allow, if not require, consideration of a global SCC and a global SCM. In fact, standards for rational rulemaking may constrain agencies from ignoring the globally interconnected costs of climate change.

D. Standards of Rationality Require Consideration of Important, Globally Interconnected Climate Costs and Counsel Against Misleading Domestic-Only Estimates

The Administrative Procedure Act, which governs regulatory and deregulatory actions under a range of contexts, empowers courts to review whether agency actions are "arbitrary and capricious."[197] The Supreme Court defined the standard for reasonable rulemakings as follows:

> Normally, an agency rule would be arbitrary and capricious if the agency has relied on factors which Congress has not intended it to consider, *entirely failed to consider an important aspect of the problem*, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view of the product of agency expertise.[198]

197. 5 U.S.C. § 706 (2012); *see also* Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 41–42 (1983) (applying the standards of review to deregulatory action and concluding that when "rescinding a rule" an agency "is obligated to supply a reasoned analysis for the change beyond that which may be required when an agency does not act in the first instance").

198. *State Farm*, 463 U.S. at 43 (emphasis added) (stating also that "we must consider whether the decision was based on a consideration of the relevant factors and whether there has been a clear error of judgment") (internal quotation marks omitted).

Furthermore, the Court found that the standard requires an agency to "examine the relevant data and articulate a satisfactory explanation for its action including a 'rational connection between the facts found and the choice made.'"[199]

Two courts of appeals have already applied arbitrary and capricious review to support the use of a global SCC in setting regulatory standards.[200] In *Center for Biological Diversity v. National Highway Traffic Safety Administration*, the U.S. Court of Appeals for the Ninth Circuit ruled that, because the agency had monetized other uncertain costs and benefits of its vehicle fuel efficiency standard, its "decision not to monetize the benefit of carbon emissions reduction was arbitrary and capricious."[201] Specifically, it was arbitrary to "assign[] no value to *the most significant benefit* of more stringent [vehicle fuel efficiency] standards: reduction in carbon emissions."[202] When an agency bases a rulemaking on cost-benefit analysis, it is arbitrary to "put a thumb on the scale by undervaluing the benefits and overvaluing the costs."[203] The court remanded the rule to the agency "to include a monetized value for this benefit in its analysis."[204] The court approvingly cited a partial consensus among experts around an estimate of "$50 per ton carbon (or $13.60 per ton CO2),"[205] which, in the year 2006 when

199. *Id.*

200. Several courts have also applied arbitrary and capricious review to the use or non-use of the SCC in environmental impact statements under NEPA. In *High Country Conservation Advocates v. U.S. Forest Service*, the District Court of Colorado found that it was "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"—specifically, by applying the "social cost of carbon protocol." 52 F. Supp. 3d 1174, 1191 (D. Colo. 2014). The District Court of Oregon declined to follow suit in *League of Wilderness Defenders v. Connaughton*, but only because in this case the Forest Service had not conducted a quantitative analysis of either costs or benefits of climate change, but rather had addressed climate change qualitatively. No. 3:12–cv–02271–HZ, 2014 WL 6977611 (D. Or. Dec. 9, 2014). Finally, in *EarthReports, Inc. v. FERC*, the Court of Appeals for the D.C. Circuit accepted, with little additional analysis, the agency's arguments for why the SCC was not required in environmental impact statements. 828 F.3d 949, 956 (D.C. Cir. 2016).

201. Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1203 (9th Cir. 2008).

202. *Id.* at 1199 (emphasis added).

203. *Id.* at 1198.

204. *Id.* at 1203.

205. *Id.* at 1199, 1201.

the rule was issued, would have been consistent with estimates of a global SCC.[206]

More recently, in *Zero Zone Inc. v. Department of Energy*, the U.S. Court of Appeals for the Seventh Circuit found that "the expected reduction in environmental costs *needs* to be taken into account" for the Department of Energy "[t]o determine whether an energy conservation measure is appropriate under a cost-benefit analysis."[207] More specifically, in response to the petitioners' challenge that the agency's consideration of the global SCC was arbitrary, the Seventh Circuit responded that the agency "acted reasonably" in considering the global climate effects.[208]

Future regulatory or deregulatory actions on greenhouse gas emissions that focus on a domestic-only SCC or otherwise ignore the global consequences of U.S. emissions could be vulnerable to arbitrary and capricious review on at least two grounds. First, under many key statutory frameworks, globally interconnected climate effects will be "an important aspect" of any regulatory or deregulatory action on climate change, and the agency may not "entirely fail to consider" those effects.[209] For example, suppose the Trump administration issued a new rule that weakened or repealed carbon dioxide limits set under the Clean Air Act. Recall that many key provisions of the Clean Air Act mandate the protection of "public welfare," where "welfare" is defined to include effects on the climate.[210]

The increased carbon emissions resulting from the deregulatory action would contribute to climate change and impose costs in several ways. Climate damages occurring within the borders of the United States will directly impose costs on public welfare. United States welfare interests in foreign businesses and property, in tourism, in global commons like the oceans, and in global existence values and altruism will also experience direct costs from the deregulation. Finally, U.S. welfare will suffer from two indirect but significant costs: the deregulation could undermine current and future foreign actions on climate that would otherwise benefit

206. *See* Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011–2015, 73 Fed. Reg. 24,352, 24,414 (May 2, 2008) (estimating that $14 per ton of carbon dioxide approximated global benefits).

207. Zero Zone, Inc. v. Dep't of Energy, 832 F.3d 654, 677 (7th Cir. 2016) (emphasis added).

208. *Id.* at 679.

209. *See* 5 U.S.C. § 706 (2012).

210. *See supra* notes 162–163 and accompanying text.

the United States, and many climate damages experienced around the world will spill back onto U.S. welfare through our multiple global interconnections—through the economy, national security, migration patterns, and communicable disease transmission. Both the direct and the indirect costs could be significant and so count as "important aspects" that an agency cannot "entirely fail to consider" during regulation.[211]

Courts overturn regulations as arbitrary when they ignore important indirect costs. For example, a National Highway Traffic Safety Administration rule was struck down by the U.S. Court of Appeals for the D.C. Circuit for failing to consider whether the benefits of more fuel-efficient cars outweighed the indirect safety risks, because smaller, more efficient cars might be less protective in a crash.[212] As the Supreme Court recently reminded the Environmental Protection Agency, "reasonable regulation ordinarily requires paying attention to the advantages *and* the disadvantages of agency decisions," where "'costs' include more than the expense of complying with regulation" but also "harms that regulation might do to human health or the environment."[213] The indirect climate costs of a deregulation that undermines foreign reciprocity and contributes to spillover effects therefore deserve attention commensurate with the deregulation's direct advantages and disadvantages.

An agency could try to account for important direct and indirect climate costs of deregulation through a qualitative rather than quantitative assessment that eschewed the SCC methodology. However, courts view critically regulations that fail to quantify a readily quantifiable factor or that quantify some costs or benefits but not other effects. The Ninth Circuit's harsh critique of the National Highway Traffic Safety Administration for not monetizing carbon reductions and so putting a "thumb on the scale" is a particularly notable case in point.[214] As another example, the D.C. Circuit has chastised agencies for "inconsistently and

211. *See* 5 U.S.C. § 706.

212. *See* Competitive Enter. Inst. v. Nat'l Highway Traffic Safety Admin., 956 F.2d 321, 326–27 (D.C. Cir. 1992); *id.* at 330 (Mikva, J., dissenting in part) (clarifying that the majority's ruling was on arbitrary and capricious review).

213. Michigan v. EPA, 135 S. Ct. 2699, 2707 (2015). Though the Michigan case was not decided on arbitrary and capricious grounds, its discussion of "reasonable" regulation overlaps considerably with jurisprudence on arbitrary and capricious review.

214. Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1203 (9th Cir. 2008).

opportunistically fram[ing] the costs and benefits of the rule [and] fail[ing] adequately to quantify certain costs or to explain why those costs could not be quantified."[215] Given that the global SCC is a well-established methodology and has been touted by experts as a proxy for both the indirect effects of international reciprocity[216] and indirect spillover effects,[217] agencies could be hard-pressed to justify not using the global SCC to account for all the important aspects of climate damages.

The second ground for arbitrary and capricious review of a focus on a domestic-only SCC estimate in regulatory or deregulatory action is the difficulty inherent in proposing any domestic-only range. Arbitrary and capricious review requires agencies to "examine the relevant data and articulate a satisfactory explanation for its action including a 'rational connection between the facts found and the choice made.'"[218] Satisfactorily articulating a rational connection between the known facts about climate damages and any specific domestic-only SCC estimate could prove nearly impossible for agencies. The interagency working group did suggest a range of 7–23% of the global SCC to generate an "approximate, provisional, and highly speculative" estimate of the purely direct climate effects to the United States.[219] This highly speculative range of percentages was based on two approaches: the results of one economic model, and the U.S. share of global GDP. Neither approach captures the very significant indirect and spillover effects to the United States, nor U.S. willingness to pay to prevent climate damages beyond its own borders. Given our multiple global interconnections—through the economy, national security, migration patterns, and communicable disease transmission—harms experienced in other parts of the world can quickly become costs to the United States, and so as a practical matter it is nearly unworkable to isolate accurately a domestic-only portion of the social costs of carbon or methane. The interagency working group had good reasons to recommend that agencies not

215. Bus. Roundtable v. SEC, 647 F.3d 1144, 1148–49 (D.C. Cir. 2011) (striking down the rule as arbitrary and capricious).

216. *See* Hendrixson, *supra* note 105 (quoting former Council of Economic Advisors Chair Jason Furman).

217. *See* Kopp & Mignone, *supra* note 15, at 833.

218. *See* Motor Vehicle Mfrs. Assoc. v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 43 (1983).

219. *See* 2010 TSD, *supra* note 4, at 11.

rely on the speculative domestic estimate in their regulatory analyses, but instead focus on the global SCC.

VI. CONCLUSION: ARGUMENTS AGAINST USING GLOBAL VALUES ARE SHORT-SIGHTED AND FALLACIOUS

Though a handful of researchers, industry trade groups, and state governments have advanced arguments against the global valuation of greenhouse gases, two economists—Ted Gayer and Kip Viscusi—have made the most detailed case.[220] Nevertheless, their arguments run counter to U.S. negotiation strategy, long-term national interests, legal requirements, and economic theory. This conclusion distills and supplements the above analysis to counter each claim made by opponents of the global SCC and global SCM.

Opponents Make Inappropriate Judgments and Inaccurate Statements About Negotiation Strategy

Waiting for all countries to sign an enforceable global agreement before the United States uses a global SCC or SCM is not the only strategy for negotiations, and backing away now from global SCC or SCM estimates could undermine existing international agreements. Opponents like Gayer and Viscusi acknowledge that foreign reciprocity can justify use of a global SCC value in analyzing U.S. policy, but they insist that use of a global SCC must wait until after a comprehensive and enforceable international treaty has been signed, for fear of undermining U.S. efforts to secure action from other countries.[221] This argument overlooks the many negotiation strategies involving an early U.S. commitment to use the global SCC that could successfully induce international reciprocity. If the existence of reciprocity would justify the use of the global SCC, then surely a workable strategy to secure reciprocity should also justify the use of the global SCC. Gayer and Viscusi's skeptical outlook about the success of these other strategies[222] is based on a particular view of the free rider problem that does not account for tit-for-tat-type strategies in a repeated negotiation, for the role of building small, stable coalitions, or for more realistic assumptions about foresight and equity.

220. Gayer & Viscusi, *supra* note 16.
221. *Id.* at 256–57.
222. *See id.* at 257–59.

Furthermore, this argument overlooks the substantial progress toward meaningful global agreements already reached. In advance of the December 2015 Paris meeting of the United Nations Framework Convention on Climate Change, member nations, including many countries most responsible for greenhouse gas emissions, announced numerical pledges to meet their share of necessary emissions reductions. One hundred eighty-seven countries have submitted plans, including China, India, Brazil, Australia, Japan, Europe, and the United States;[223] submissions cover countries responsible for over 95% of global emissions.[224] Two other international agreements were recently finalized in October 2016. First, nearly 200 countries, including the United States, agreed to phase out a particularly potent category of greenhouse gases called hydrofluorocarbons.[225] Second, the United States and 190 other countries agreed to targets to reduce greenhouse gas emissions from international flights.[226] Given this state of international negotiations, should the United States now back away from the global SCC, it could encourage other countries to similarly ignore the global externalities of their emissions and abandon their pledges.

Other countries are already considering the benefits of their actions to the United States by using a global SCC and global SCM.[227] Gayer and Viscusi assert that "there is no compelling rationale for adopting a global SCC based on other countries' practices."[228] However, Canada and Mexico have pledged to harmonize their SCC values with U.S. global estimates, and Sweden, Germany, the United Kingdom, Norway, and the European Union have all independently chosen a global SCC for use in their regulatory analyses; the United Kingdom uses a global SCM as well. Other countries, like France and Switzerland, have implemented high carbon taxes or carbon allowance prices that effectively reflect the global damages of emissions.

Agencies have in fact presented domestic-only numbers in appropriate contexts, but rightly keep the focus on the global

223. *INDCs as Communicated by Parties*, *supra* note 83.

224. *Tracking INDCs*, *supra* note 84.

225. Fact Sheet: Nearly 200 Countries Reach Global Deal to Phase Down Potent Greenhouse Gases and Avoid Up to 0.5°C of Warming, *supra* note 86.

226. Fact Sheet: 191 Countries Reach a Global Climate Deal for International Aviation, *supra* note 86.

227. See *infra* Appendix B and accompanying sources for more information.

228. Gayer & Viscusi, *supra* note 16, at 259.

perspective. Opponents claim that agencies never report domestic-only climate benefits. Not only would a domestic-only approach be misleading, but this claim is factually incorrect. For example, the Department of Energy's recent technical support document for its energy efficiency standards for residential furnace fans calculated the domestic present value of greenhouse gas reductions from various proposed stringencies (still worth hundreds of millions of dollars).[229] Nevertheless, the Department of Energy rightly emphasized the global benefits, and other agency regulations do appropriately focus exclusively on global climate benefits.

Emphasizing domestic-only presentations would be misleading. The 7–23% range is, at best, imprecise, and reflects the United States' minimum share of climate benefits because it ignores very significant indirect and spillover effects to the United States, as well as U.S. willingness to pay to prevent climate damages beyond its own borders.[230] Giving these preliminary and speculative domestic estimates too much attention risks creating false certainty and misguiding the public about what is at stake for the United States. It also fails to account for the U.S. interest in adopting policies that will spur international reciprocity and so create additional U.S. benefits from foreign actions. Moreover, failing to emphasize the global benefits could signal to other countries that the United States is not committed to a global approach on climate, and could invite other countries to also discount or disregard the effect of their emissions on the United States. Whether the United States is employing a strategy of tit-for-tat, coalition building, leading by example, or building a reputation for equity, it is in the United States' strategic interest to continue emphasizing global SCC and SCM values, rather than sending mixed signals.

229. U.S. DEP'T OF ENERGY, TECHNICAL SUPPORT DOCUMENT: ENERGY EFFICIENCY PROGRAM FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT—RESIDENTIAL FURNACE FANS, at 14-7 (2013).

230. Opponents like Gayer and Viscusi claim that the 7–23% range is likely an overestimate, because the U.S. GDP will likely decrease as a share of world GDP over the long timeframe assessed in climate regulations. *See* Gayer & Viscusi, *supra* note 16, at 253. However, this assumption is very speculative and does not account for how climate change may depress the economic growth of rising nations like China. Moreover, it does not account for the many ways in which the range is an underestimate, by omitting damage categories and ignoring spillover effects. *See* William Nordhaus, *Estimate of the Social Cost of Carbon: Concepts and Results from the DICE-2013R Model and Alternative Approaches*, 1 J. ASS'N ENVTL. & RESOURCE ECON. 273, 290 (2014) ("[T]he different estimates reflect the poor understanding of the impacts by region.").

Opponents Make Inaccurate Statements About Legal Requirements and Agency Practices

White House guidance on regulatory analysis supports, and certainly does not preclude, using the global SCC or SCM. In 1993, President Clinton signed Executive Order 12,866, which remains the foundational order governing federal regulatory planning and review.[231] Order 12,866 requires agencies to assess the costs and benefits of significant regulatory proposals and empowers the Office of Information and Regulatory Affairs to review such proposals.[232] While some critics of the global SCC or global SCM have highlighted the Order's requirement for federal agencies to "promulgate only such regulations as . . . [are necessary to] protect or improve the health and safety of the public, the environment, or the well-being of the American people,"[233] the well-being of the American people is directly advanced by efforts to encourage international reciprocity on climate change. Order 12,866 never limits agencies to considering only domestic effects, instead instructing agencies to "assess *all* costs and benefits."[234]

The Office of Information and Regulatory Affairs has developed guidance for agencies (the "Circular") on compliance with Executive Order 12,866. Published in 2003, the Circular assumes—as critics of the global SCC are quick to point out—that most analyses would focus on domestic costs and benefits. However, ultimately it defers to the discretion of regulatory agencies on whether to evaluate "effects beyond the borders of the United States."[235] The Circular notes that "facilitating U.S. participation in

231. Exec. Order No. 12,866, 58 Fed. Reg. 51,735 (Sept. 30, 1993).

232. *Id.*

233. *Id.* § 1(a), *cited by* Gayer & Viscusi, *supra* note 16; Fraas et al., *supra* note 17.

234. Exec. Order No. 12,866, 58 Fed. Reg. 51,735, § 1(a) (emphasis added).

235. Office of Mgmt. & Budget, *supra* note 137; *see also* Advanced Notice of Proposed Rulemaking on Regulating Greenhouse Gas Emissions Under the Clean Air Act, 73 Fed. Reg. 44,354, 44,415 (July 30, 2008) ("Typically, because the benefits and costs of most environmental regulations are predominantly domestic, EPA focuses on benefits that accrue to the U.S. population when quantifying the impacts of domestic regulation. However, OMB's guidance for economic analysis of federal regulations specifically allows for consideration of international effects.").

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

global markets should also be considered. Harmonization of U.S. and international rules may require a strong Federal regulatory role."[236] Importantly, more recent executive orders and guidance clarify that a global perspective on climate costs is required. In 2012, President Obama issued Executive Order 13,609 on promoting international regulatory cooperation.[237] Executive Order 13,609 recognizes that significant regulations can have "significant international impacts,"[238] and it calls on federal agencies to work toward "best practices for international regulatory cooperation with respect to regulatory development."[239]

Moreover, the Office of Information and Regulatory Affairs was also part of the interagency working group on the social cost of carbon. The working group was specifically charged with developing recommendations for "regulatory impact analysis under Executive Order 12,866."[240] The interagency working group's technical support documents, therefore, state the White House's official policy on conducting Executive Order 12,866 analyses of climate regulations, and of course, the group has selected a global valuation for the social cost of carbon. Finally, certain statutory mandates, like the Clean Air Act's section 115, will further override executive guidance in some regulatory contexts.

The Clean Air Act supports, and certainly does not preclude, using the global SCC or SCM. Opponents argue that the Clean Air Act is predominantly focused on protecting only domestic air quality, except for a limited provision that allows EPA to give some weight (though not equal weight) to foreign benefits in countries

costs, and transfers from other nations to the United States as benefits, as long as the analysis is conducted from the United States perspective." Office of Mgmt. & Budget, *supra* note 137. 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 confer benefits on the United States. *See* Comments from Michael A. Livermore et al., Inst. for Pol'y Integrity, to U.S. Envtl. Prot. Agency 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).

236. Office of Mgmt. & Budget, *supra* note 137; *see also* U.S. OFFICE OF MGMT & BUDGET & SECRETARIAT GEN. OF THE EUROPEAN COMM'N, *supra* note 6, at 11–13 (explaining that Executive Order 12,866's reference to private markets and competitiveness obligates agencies to consider impacts on international trade).

237. Exec. Order No. 13,609, 77 Fed. Reg. 26,413 (May 1, 2012).

238. *Id.* § 3(b).

239. *Id.* § 2(a)(ii)(B) (defining the goals of the regulatory working group).

240. *See* 2010 TSD, *supra* note 4.

that have granted the United States reciprocal rights.[241] Yet, as discussed above, since 1965, the Clean Air Act has expressed a consistent concern for the effects of U.S. emissions on foreign health and welfare. Section 115 explicitly requires the United States to address the danger U.S. emissions cause to foreign health and welfare, so long as foreign countries take on some reciprocity responsibility. Moreover, the term "welfare," as used throughout the statute, has been interpreted by courts to cover not just the protection of local air quality, but also precisely the type of global effects on climate caused by greenhouse gas emissions.

The Clean Water Act, though to date not central to U.S. climate regulations, would also support using the global SCC. Gayer and Viscusi claim that section 311 of the Clean Water Act shows an exclusive focus on national interests.[242] Had they looked one section earlier in the statute, they would have seen that section 310, titled "International Pollution Abatement," partly mirrors section 115 of the Clean Air Act and requires certain actions where other countries have given reciprocal rights.[243] Similarly, section 101 instructs the President to secure meaningful action from foreign countries to prevent the pollution of international waters to the same extent that the United States does.[244] Since the Clean Water Act may apply to water acidification caused by carbon dioxide emissions,[245] the same legal and strategic factors explored above for the Clean Air Act could require use of the global SCC for future regulatory analysis done under the Clean Water Act. However, to date, the Clean Water Act has not been used directly to set U.S.

241. Gayer and Viscusi suggest that section 115 can only be triggered by the Secretary of State. Gayer and Viscusi, *supra* note 16, at 250. But section 115 also empowers EPA to act directly. *See* 42 U.S.C. § 7415 (2012).

242. Gayer and Viscusi also claim the Exxon Valdez oil spill as legal precedent, since the monetary damages paid reflected only calculations of U.S. impacts (and not, for example, to Canada). Gayer & Viscusi, *supra* note 16, at 251. Not only do oil spills present a very different context than climate change, especially from an international negotiation strategy perspective, but a single consent decree from twenty-five years ago makes for a poor precedent, and would not preclude EPA or other agencies from assessing global damages today as appropriate.

243. 33 U.S.C. § 1320 (2012).

244. *Id.* § 1251(c).

245. *See* Allison Winter, *Some See Clean Water Act Settlement Opening New Path to GHG Curbs*, N.Y. TIMES (Mar. 12, 2010), http://www.nytimes.com/gwire/2010/03/12/12greenwire-some-see-clean-water-act-settlement-opening-new-4393.html [https://perma.cc/7F2W-BKFU]; U.S. ENVTL. PROT. AGENCY, QUESTIONS AND ANSWERS ON OCEAN ACIDIFICATION AND THE CLEAN WATER ACT 303(D) PROGRAM (2010) (explaining that states should list waters for ocean acidification under section 303(d) when sufficient data exists).

climate policy, though a few Clean Water Act regulations have indirectly affected the energy sector and so have calculated the value of greenhouse gas reductions.[246]

The Toxic Substance Control Act ("TSCA") is likely irrelevant to climate regulation. Gayer and Viscusi cite a controversial judicial ruling under the TSCA, which found that Canadian petitioners did not have standing to challenge EPA's regulations in court because one of the statute's many factors references the national economy, and because the statute does not mention international concerns.[247] First, "legal standing" (that is, the right to sue in court) is different from "economic standing" (that is, the right to be considered as part of the relevant affected population in a cost-benefit analysis). Second, concerns about the court's very narrow view of cost-benefit analysis in that particular case in part drove the recent congressional efforts to reform TSCA.[248] Third, TSCA appears to be essentially irrelevant to greenhouse gas regulation.[249] Even assuming that TSCA did foreclose consideration of international effects, that would in no way affect any agency's discretion when acting under any other statutory authority.

Past practices support, and do not preclude, using the global SCC and SCM. Gayer and Viscusi claim that only one environmental impact statement has ever considered non-U.S. effects.[250] Not only does past practice not tie the hands of current and future agencies, especially when faced with a very different kind of environmental and strategic problem like climate change, but there are several important examples of agencies considering foreign effects in their regulatory analyses. For example, even Gayer and Viscusi implicitly reference the fact that EPA has

246. *See infra* Appendix A.

247. Gayer & Viscusi, *supra* note 16, at 251.

248. Press Release, U.S. Sen. Comm. on Env't & Pub. Works, Senator Barbara Boxer Calls on EPA to Act Now on Dangerous Asbestos Under the New TSCA Law (Aug. 26, 2016), http://www.epw.senate.gov/public/index.cfm/2016/8/senator-barbara-boxer-calls-on-epa-to-act-now-on-dangerous-asbestos-under-the-new-tsca-law [https://perma.cc/W59E-3UMF]; Matthew W. Morton et al., *A New Day in Chemical Regulation: What You Need to Know about the 2016 TSCA Amendments*, PILLSBURY WINTHROP SHAW PITTMAN LLP (June 13, 2016), https://www.pillsburylaw.com/siteFiles/Publications/AlertJune2016ELUNRANewDayinChemicalRegulation.pdf [https://perma.cc/4NRC-SNF3].

249. A search on LexisNexis did not reveal a single law review or newspaper article arguing for use of TSCA to regulate greenhouse gas emissions. The only exceedingly indirect connection between TSCA and greenhouse gases is the possible application of TSCA to regulate the effects of natural gas fracking on water (fracking may also release methane).

250. Gayer & Viscusi, *supra* note 16, at 252.

previously considered cross-border effects of pollutants like mercury.[251]

Complexities in the scientific modeling and data limitations make quantification of the health benefits of mercury reductions very difficult. As a result, EPA only discussed the foreign health benefits of U.S. mercury reductions qualitatively; however, most of the domestic health benefits were also unquantified, for similar reasons.[252] In other contexts, agencies have emphasized a quantified global effect. For example, when estimating the risk of death from debris from the international space station, NASA focused on the risk to the global population.[253]

Agencies also assess how U.S. regulations may prompt foreign reactions that in turn affect U.S. welfare. For example, when dealing with the analogously global environmental problem of ozone-depleting substances, the Food and Drug Administration under the George W. Bush administration noted that the U.S. health gains "could be magnified if other countries follow suit and further reduce emissions."[254]

Opponents Present a Grossly Misleading Slippery Slope

Using a global SCC or SCM would not alter policy in any other, non-climate context. Gayer and Viscusi make the claim that using

251. *Id.* at 256.

252. 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. U.S. ENVTL. PROT. AGENCY, REGULATORY IMPACT ANALYSIS FOR THE FINAL MERCURY AND AIR TOXICS STANDARDS 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."). 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. Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 75 Fed. Reg. 45,210, 45,351 (proposed Aug. 2, 2010).

253. NAT'L AERONAUTICS & SPACE ADMIN., FINAL TIER 2 ENVIRONMENTAL IMPACT STATEMENT FOR INTERNATIONAL SPACE STATION, at 3-1, 3-7, 4-30 (1996). NASA did calculate the domestic risk separately, but most of the report emphasized the global risk.

254. Use of Ozone-Depleting Substances; Removal of Essential-Use Designations, 69 Fed. Reg. 33,602, 33,612 (proposed June 16, 2004); *see also* Use of Ozone-Depleting Substances; Removal of Essential-Use Designations, 72 Fed. Reg. 32,030 (proposed June 11, 2007).

the global SCC could precipitate dramatic shifts in U.S. policy and allocation of resources:

> If such a global perspective [as with the global SCC] were applied broadly to the benefit assessments of all policies, it would substantially alter the allocation of societal resources in a manner that would not reflect the preferences of the U.S. citizens who are bearing the cost of such policies and whose political support is required to maintain such efforts.[255]

This imagined slippery slope would not result automatically from the strategic selection to use the global SCC or SCM in setting U.S. climate policy. If the United States ever adopted a purely utilitarian decision-making framework and granted everyone on the planet equal economic standing, then, yes, reallocation of resources to poorer countries would be required. But selecting the global SCC or SCM in no way commits the United States to a purely utilitarian or cosmopolitan framework.

U.S. climate policies and negotiation strategies are about correcting a global externality for which the United States, along with other global actors, is directly responsible, and which also directly harms the United States. Though the United States is now only the second-largest greenhouse gas emitter (after China), some studies estimate that, overall, no country comes close to matching the total, historic U.S. contribution to climate change.[256] Taking responsibility for our own significant role in causing climate change does not mean the United States should, as a general policy matter, prioritize global over domestic welfare. Gayer and Viscusi have conflated two very different things.

Using the global SCC or SCM may require consideration of some, but certainly not all, global costs and consequences. Gayer and Viscusi argue that the principle of symmetrical analysis requires that, if the global SCC is used to measure benefits, then U.S. regulatory analysis must account for all global costs as well.[257] Gayer and Viscusi do not define which global costs they have in

255. Gayer & Viscusi, *supra* note 16, at 261.

256. Datablog, *A History of CO_2 Emissions*, THE GUARDIAN (Sept. 2, 2009), https://www.theguardian.com/environment/datablog/2009/sep/02/co2-emissions-historical [https://perma.cc/KES2-LC3B]. From 1900–2004, the United States emitted 314,772.1 million metric tons of carbon dioxide. Russia and China follow with only around 89,000 million metric tons each.

257. Gayer & Viscusi, *supra* note 16, at 257.

mind, but the petitioners challenging the use of the global SCC in EPA's Clean Power Plan analysis seemed most concerned about emissions leakage. As explained in their brief, the petitioners felt EPA's economic analysis "overstates emissions reductions by ignoring that industries respond to energy price increases by shifting production abroad. This depresses benefits because those businesses do not reduce—and may increase—emissions."[258] In short, if a U.S. regulation causes industry to shift production to countries with no or lax emissions controls, the result may be a costly increase of emissions, also called "emissions leakage."

Emissions leakage and other important negative global effects should be included in the analysis of federal climate policies, to the extent feasible and to the extent such negative effects exist. Yet the appropriate response to leakage certainly is not to abandon use of the global SCC or SCM; in fact, since using the global SCC and SCM can induce international cooperation on climate change, it actually addresses the problem of leakage. Leakage costs should be modeled when applying the global SCC or SCM. In the case of EPA's Clean Power Plan, for example, the agency analyzed the issue and concluded that it did "not see evidence" of likely "emissions leakage" due to "the relatively modest changes in electricity prices."[259] Nevertheless, EPA qualitatively assesses how rising electricity prices may lead to substitution of goods. While some substitutes could be imports from countries with higher emissions per production unit, resulting in foreign emissions increases, other substitutes would be to alternate domestic goods or even to imports from countries with less intensive emissions.[260] EPA also discussed how U.S. regulation could motivate foreign countries to adopt their own climate policies, mitigating the risk of leakage. To the extent there is some remaining chance of unquantified leakage costs, note that regulatory actions like the Clean Power Plan also generate many unquantified benefits.[261]

258. Opening Brief for Petitioners, *supra* note 13, at 71.

259. U.S. ENVTL. PROT. AGENCY, RESPONSES TO PUBLIC COMMENTS ON THE EPA'S CARBON POLLUTION EMISSION GUIDELINES FOR EXISTING STATIONARY SOURCES: ELECTRIC UTILITY GENERATING UNITS ch. 8, § 8.7.2, at 77 (2015), https://www.regulations.gov/document?D=EPA-HQ-OAR-2013-0602-37106.

260. U.S. ENVTL. PROT. AGENCY, REGULATORY IMPACT ANALYSIS FOR THE CLEAN POWER PLAN FINAL RULE, at 5-5–5-6 (2015).

261. *Id.* at 4-46–5-56 (listing qualitative benefits from hazardous pollutant reductions and visibility improvements).

Other climate regulations may not raise much concern of leakage. For example, the majority of regulatory actions that have used the SCC or SCM to date are energy efficiency standards, many of which will deliver private savings on electricity bills as well as social benefits. Regulation of energy efficiency for passenger cars and residential appliances, for example, should not pose significant risks of foreign leakage: making U.S. home refrigerators more efficient has no effect on foreign emissions.

Some other global "costs" of regulation may really have only distributional effects. For example, when U.S. regulations increase the fuel economy of motor vehicles, U.S. demand for gasoline drops, and because of role that U.S. consumers play in the global oil market, worldwide gasoline prices will dip as well. The lower prices result in a "monopsony benefit" to U.S. consumers, but also result in an offsetting loss in revenue to foreign oil producers. In recent fuel economy rules, EPA and the Department of Transportation have not counted the monopsony benefit (or, put another way, they have counted the offsetting global costs to foreign producers, which zeroed out any domestic monopsony benefits) because they felt using a global SCC necessitated a global perspective on certain costs as well.[262] However, the monopsony effects are really distributional in nature, involving simply the transfer of money between domestic consumers and foreign producers, and do not implicate the economic efficiency of the climate regulation. Consequently, U.S. agencies arguably could be justified in taking a domestic perspective on purely distributional effects even while using the global SCC or SCM.[263]

Finally, compliance cost estimates should always, to the extent practical, factor in the potential for cost-saving innovation, learning, and adaptation. For example, by forging the path and uncovering the most cost-effective tools for greenhouse gas abatement, the United States can transfer technology and knowledge to developing countries, enabling them to achieve more ambitious emissions reductions at achievable costs—reductions that, again, will directly benefit the United States. In the context of climate change policy analysis, thinking globally will help the United States to benefit locally.

262. Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Vehicles and Engines—Phase 2, 80 Fed. Reg. 40,138, 40,467 (proposed July 13, 2015).

263. *See* Office of Mgmt. & Budget, *supra* note 137; *see also* Comments from Livermore et al. to U.S. Envtl. Prot. Agency, *supra* note 235, at 12–13.

APPENDICES

Appendix A: Regulatory Proceedings that Apply the SCC or SCM[264]

Rulemaking	Agencies & Statutory Authorities	Publication Date and Citation	Global vs. Domestic
Energy Conservation Standards for Refrigerated Bottled or Canned Beverage Vending Machines	DOE, Energy Policy statutes ("EPCA etc.")	74 Fed. Reg. 44,914 (finalized Aug. 31, 2009) RIN 1904-AB58	Global emphasized; one domestic estimate presented in tables alongside five global estimates in preamble
Light-Duty Vehicle Greenhouse Gas Standards and Corporate Average Fuel Economy Standards	EPA, CAA; Dep't of Transp. ("DOT"), EPCA etc.	74 Fed. Re. 49,454 (proposed Sept. 28, 2009); 75 Fed. Reg. 25,323 (finalized May 7, 2010) RIN 2127-AK50; RIN 2127-AK90; RIN 2060-AP58	Global emphasized; domestic discussed and presented in sensitivity analysis table
Energy Conservation Standards for Dishwashers, Dehumidifiers, Microwave Ovens, Electric & Gas Kitchen Ranges and Ovens, and Commercial Clothes Washers	DOE, EPCA etc.	74 Fed. Reg. 57,738 (proposed Nov. 9, 2009); 75 Fed. Reg. 1121 (finalized Jan. 8, 2010) RIN 1904-AB93	Global emphasized; one domestic estimate presented in tables alongside five global estimates in preamble
Energy Conservation Standards for Small Electric Motors	DOE, EPCA etc.	74 Fed. Reg. 61,410 (proposed Nov. 24, 2009); 75 Fed. Reg. 10,874 (finalized Mar. 9, 2010) RIN 1904-AB70	Global emphasized; one domestic estimate presented in tables alongside five global estimates in preamble

[264] Appendix A reflects developments since the interagency working group's interim values were first available, through July 2016.

Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters	DOE, EPCA etc.	74 Fed. Reg. 65,852 (proposed Dec. 11, 2009); 75 Fed. Reg. 20,111 (finalized Apr. 16, 2010) RIN 1904-AA90	Global emphasized; one domestic estimate presented in tables alongside five global estimates in preamble
Changes to Renewable Fuel Standard Program	EPA, CAA	75 Fed. Reg. 14,669 (Mar. 26, 2010) RIN 2060-A081	Global only
FIP to Reduce Interstate Transport of Fine Particulate Matter and Ozone	EPA, CAA	75 Fed. Reg. 45,209 (proposed Aug. 2, 2010); 76 Fed. Reg. 48,207 (finalized Aug. 8, 2011) RIN 2060-AP50	Global only
Energy Conservation Standards for Residential Refrigerators, Refrigerator-Freezers, and Freezers	DOE, EPCA etc.	75 Fed. Reg. 59,470 (proposed Sept. 27, 2010); 76 Fed. Reg. 57,515 (finalized Sept. 15, 2011) RIN 1904-AB79	Global emphasized; domestic range discussed in preamble
NSPS and Emission Guidelines for Sewage Sludge Incineration Units	EPA, CAA	75 Fed. Reg. 63,260 (proposed Oct. 14, 2010); 76 Fed. Reg. 15,372 (finalized Mar. 21, 2011) RIN 2060-AP90	Global only, calculating carbon dioxide disbenefits (i.e., costs) calculated in regulatory impact analysis
GHG Emission Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles	EPA, CAA; DOT, EPCA etc.	75 Fed. Reg. 74,152 (proposed Nov. 30, 2010); 76 Fed. Reg. 57,105 (finalized Sept. 15, 2011) RIN 2060-AP61; RIN 2127-AK74	Global only

NESHAP: Mercury Emissions from Mercury Cell Chlor-Alkali Plants	EPA, CAA	76 Fed. Reg. 13,852 (proposed Mar. 14, 2011) RIN 2060-AN99	Global only
NESHAP: Industrial, Commercial, and Institutional Boilers (Area Sources)	EPA, CAA	76 Fed. Reg. 15,554 (Mar. 21, 2011) RIN 2060-AM44	Global only, valuing disbenefits
NESHAP: Industrial, Commercial, and Institutional Boilers and Process Heaters (Major Sources)	EPA, CAA	76 Fed. Reg. 15,607 (Mar. 21, 2011) RIN 2060-AQ25	Global only, valuing disbenefits in regulatory impact analysis
NSPS and EG: Commercial and Industrial Solid Waste Incineration Units	EPA, CAA	76 Fed. Reg. 15,704 (Mar. 21, 2011) RIN 2060-AO12	Global only, valuing disbenefits
Energy Conservation Standards for Fluorescent Lamp Ballasts	DOE, EPCA etc.	76 Fed. Reg. 20,090 (proposed Apr. 11, 2011); 76 Fed. Reg. 70, 547 (finalized Nov. 14, 2011) RIN 1904-AB50	Domestic discussed in preamble Separate calculations of domestic and global in regulatory impact analysis, though emphasis on global
Energy Conservation Standards for Residential Clothes Dryers and Room Air Conditioners	DOE, EPCA etc.	76 Fed. Reg. 22,324 (proposed Apr. 21, 2011); 76 Fed. Reg. 22,453 (direct final rule, Apr. 21, 2011); 76 Fed. Reg. 22,454 (direct final rule, May 26, 2011) RIN 1904-AA89	Separate tables of domestic and global in TSD, though emphasis on global

Energy Conservation Standards for Residential Furnaces and Residential Central Air Conditioners and Heat Pumps	DOE, EPCA etc.	76 Fed. Reg. 37,549 (proposed June 27, 2011); 76 Fed. Reg. 37,407 (direct final rule, June 27, 2011) RIN 1904-AC06	Separate tables of domestic and global in TSD, though emphasis on global
Federal Implementation Plans: Interstate Transport of Fine Particulate Matter and Ozone	EPA, CAA	76 Fed. Reg. 48,207 (Aug. 8, 2011)	Global only
NSPS and NESHAP for Oil and Natural Gas Sector	EPA, CAA	76 Fed. Reg. 52,738 (proposed Aug. 23, 2011); 77 Fed. Reg. 49,489 (finalized Aug. 16, 2012) RIN 2060-AP76	Global emphasized, though domestic discussed
2017+ Model Year Light-Duty Vehicle Greenhouse Gas Standards and Corporate Average Fuel Economy Standards & DOT's environmental impact statement	EPA, CAA; DOT, EPCA etc.; NEPA	76 Fed. Reg. 74,854 (proposed Dec. 1, 2011); 77 Fed. Reg. 62,623 (finalized Oct. 15, 2012) RIN 2060-AQ54; RIN 2127-AK79	Global only
Commercial and Industrial Solid Waste Incineration Units	EPA, CAA (in conjunction with the Resource Conservation & Recovery Act)	76 Fed. Reg. 80,452 (proposed Dec. 23, 2011) RIN 2050-AG44; RIN 2060-AR15	Global only, calculating carbon dioxide disbenefits (i.e., costs) in the regulatory impact analysis
Energy Conservation Standards and Test Procedures for Commercial Heating, Air-Conditioning, and Water-Heating Equipment	DOE, EPCA etc.	77 Fed. Reg. 2356 (proposed Jan. 17, 2012); 77 Fed. Reg. 28,927 (finalized May 16, 2012) RIN 1904-AC47	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global

Energy Conservation Standards for Distribution Transformers	DOE, EPCA etc.	77 Fed. Reg. 7281 (proposed Feb. 10, 2012); 78 Fed. Reg. 23,335 (finalized Apr. 18, 2013) RIN 1094-AC04	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Standby Mode and Off Mode for Microwave Ovens	DOE, EPCA etc.	77 Fed. Reg. 8526 (proposed Feb. 14, 2012); 78 Fed. Reg. 36,316 (finalized June 17, 2013) RIN 1904-AC07	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
NESHAP from Coal- and Oil-Fired Electric Utility Steam Generation Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units	EPA, CAA etc.	77 Fed. Reg. 9303 (Feb. 16, 2012) RIN 2060-AP52; RIN 2060-AR31	Global only
Energy Conservation Standards for Battery Chargers and External Power Supplies	DOE, EPCA etc.	77 Fed. Reg. 18,477 (proposed Mar. 27, 2012); 79 Fed. Reg. 7845 (finalized Feb. 10, 2014) RIN 1904-AB57	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Residential Dishwashers	DOE, EPCA etc.	77 Fed. Reg. 31,964 (proposed May 30, 2012); 77 Fed. Reg. 31,917 (direct final rule, May 30, 2012); 77 Fed. Reg. 59,712 (direct final rule, Oct. 1, 2012) RIN 1904-AC64	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global

Energy Conservation Standards for Residential Clothes Washers	DOE, EPCA etc.	77 Fed. Reg. 32,381 (proposed May 31, 2012); 77 Fed. Reg. 32,307 (direct final rule, May 31, 2012) RIN 1904-AB90	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Performance Standards for Petroleum Refineries	EPA, CAA	77 Fed. Reg. 56,422 (Sept. 12, 2012) RIN 2060-AN72	Global only
NESHAP for Industrial, Commercial, and Institutional Boilers and Process Heaters (Major Sources)	EPA, CAA	78 Fed. Reg. 7138 (Jan. 31, 2013) RIN 2060-AR13	Global only, calculating carbon dioxide disbenefits in the regulatory impact analysis
Energy Conservation Standards for Distribution Transformers	DOE, EPCA etc.	78 Fed. Reg. 23,335 (Apr. 18, 2013) RIN 1904-AC04	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Effluent Limitation Guidelines and Standards for the Steam Electric Power Generating Point Source Category	EPA, Clean Water Act ("CWA")	78 Fed. Reg. 34,431 (proposed June 7, 2013); 80 Fed. Reg. 67,837 (finalized Nov. 3, 2015) RIN 2040-AF14	Global only
Environmental Assessment of Montana Oil and Gas Lease Sales	DOI, NEPA	Envtl. Assessment (July 24, 2013) DOI-BLM-MT-0010-2013-0022-EA	Global only

Energy Conservation Standards for Metal Halide Lamp Fixtures	DOE, EPCA etc.	78 Fed. Reg. 51,463 (proposed Aug. 20, 2013); 79 Fed. Reg. 7745 (finalized Feb. 10, 2014) RIN 1904-AC00	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Walk-In Coolers and Freezers	DOE, EPCA etc.	78 Fed. Reg. 55,781 (proposed Sept. 11, 2013); 79 Fed. Reg. 32,049 (finalized June 3, 2014) RIN 1904-AB86	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Commercial Refrigeration Equipment	DOE, EPCA etc.	78 Fed. Reg. 55,889 (proposed Sept. 11, 2013); 79 Fed. Reg. 17,725 (finalized Mar. 28, 2014) RIN 1904-AC19	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Residential Furnace Fans	DOE, EPCA etc.	78 Fed. Reg. 64,067 (proposed Oct. 25, 2013); 79 Fed. Reg. 38,129 (finalized July 3, 2014) RIN 1904-AC22	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Commercial and Industrial Electric Motors	DOE, EPCA etc.	78 Fed. Reg. 73,589 (proposed Dec. 6, 2013); 79 Fed. Reg. 30,933 (finalized May 29, 2014) RIN 1904-AC28	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global

Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units	EPA, CAA	79 Fed. Reg. 1429 (proposed Jan. 8, 2014); 80 Fed. Reg. 64,509 (finalized Oct. 23, 2015) RIN 2060-AQ91	Global only, in regulatory impact analysis
Energy Conservation Standards for Commercial Clothes Washers	DOE, EPCA etc.	79 Fed. Reg. 12,301 (proposed Mar. 4, 2014); 79 Fed. Reg. 74,491 (finalized Dec. 15, 2014) RIN 1904-AC77	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Automatic Commercial Ice Makers	DOE, EPCA etc.	79 Fed. Reg. 14,845 (proposed Mar. 17, 2014); 80 Fed. Reg. 4645 (finalized Jan. 28, 2015) RIN 1904-AC39	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Affordability Determination—Energy Efficiency Standards	Dep't of Housing and Urban Dev., Dep't of Agric. ("USDA"), Energy Independence and Security Act ("EISA")	79 Fed. Reg. 21,259 (notice of preliminary determination, Apr. 15, 2014); 80 Fed. Reg. 25,901 (final determination, May 6, 2015) RIN 2501-ZA01	Global only
Energy Conservation Standards for General Service Fluorescent Lamps and Incandescent Reflector Lamps	DOE, EPCA etc.	79 Fed. Reg. 24,067 (proposed Apr. 29, 2014); 80 Fed. Reg. 4041 (finalized Jan. 26, 2015) RIN 1904-AC43	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global

Environmental Assessment for the Miles City Oil and Gas Lease Sale	DOI, NEPA	Envtl. Assessment (May 19, 2014) DOI-BLM-MT-C020-2014-0091-EA	Global only
Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units	EPA, CAA	79 Fed. Reg. 34,829 (proposed June 18, 2014); 80 Fed. Reg. 64,661 (finalized Oct. 23, 2015) RIN 2060-AR33	Global only
National Pollutant Discharge Elimination System: Cooling Water Intake Structures at Existing Facilities	EPA, CWA	79 Fed. Reg. 48,300 (Aug. 15, 2014) RIN 2040-AE95	Global only
Energy Conservation Standards for Packaged Terminal Air Conditioners and Packaged Terminal Heat Pumps	DOE, EPCA etc.	79 Fed. Reg. 55,537 (proposed Sept. 16, 2014); 80 Fed. Reg. 43,161 (finalized July 21, 2015) RIN 1904-AC82	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Small, Large, and Very Large Air-Cooled Commercial Package Air Conditioning and Heating Equipment	DOE, EPCA etc.	79 Fed. Reg. 58,947 (proposed Sept. 30, 2014); 81 Fed. Reg. 2419 (direct final rule, Jan. 15, 2016) RIN 1904-AC95; RIN 1904-AD11	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Fossil Fuel-Generated Energy Consumption Reduction for New Federal Buildings and Major Renovations of Federal Buildings	DOE, EPCA etc.	79 Fed. Reg. 61,693 (proposed Oct. 14, 2014) RIN 1904-AB96	Global only
Carbon Pollution Emission Guidelines for Existing Stationary Sources: EGUs in Indian Country and U.S. Territories	EPA, CAA	79 Fed. Reg. 65,481 (proposed Nov. 4, 2014) RIN 2060-AR33	Global only

Energy Conservation Standards for Residential Dishwashers	DOE, EPCA etc.	79 Fed. Reg. 76,141 (proposed Dec. 19, 2014) RIN 1904-AD2	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Single Package Vertical Air Conditioners and Heat Pumps	DOE, EPCA etc.	79 Fed. Reg. 78,613 (proposed Dec. 30, 2014); 80 Fed. Reg. 57,437 (finalized Sept. 23, 2015) RIN 1904-AC85	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Single Package Vertical Air Conditioners and Heat Pumps	DOE, EPCA etc.	79 Fed. Reg. 78,613 (proposed Dec. 30, 2014); 80 Fed. Reg. 57,437 (finalized Sept. 23, 2015) RIN 1904-AC85	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Commercial Heating, Air-Conditioning, and Water-Heating Equipment	DOE, EPCA etc.	80 Fed. Reg. 1171 (proposed Jan. 8, 2015); 80 Fed. Reg. 42,613 (finalized July 17, 2015) RIN 1904-AD23	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Commercial Warm Air Furnaces	DOE, EPCA etc.	80 Fed. Reg. 6181 (proposed Feb. 4, 2015) RIN 1904-AD11	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global

Energy Conservation Standards for Hearth Products	DOE, EPCA etc.	80 Fed. Reg. 7081 (proposed Feb. 9, 2015) RIN 1904-AD35	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Environmental Assessment of Little Willow Creek Protective Oil and Gas Leasing	DOI, NEPA	Envtl. Assessment (Feb. 10, 2015) DOI-BLM-ID-B010-2014-0036-EA	Global only
Energy Conservation Standards for Residential Furnaces	DOE, EPCA etc.	80 Fed. Reg. 13,119 (proposed Mar. 12, 2015) RIN 1904-AD20	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Residential Boilers	DOE, EPCA etc.	80 Fed. Reg. 17,221 (proposed Mar. 31, 2015); 81 Fed. Reg. 2319 (finalized Jan. 15, 2016) RIN 1904-AC88	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Pumps	DOE, EPCA etc.	80 Fed. Reg. 17,825 (proposed Apr. 2, 2015); 81 Fed. Reg. 4367 (finalized Jan. 26, 2016) RIN 1904-AC54	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Final Environmental Impact Statement for Four Corners Power Plant and Navajo Mine Energy Project	DOI, NEPA	Envtl. Impact Statement (May 1, 2015) EIS No. 20150119	Global only

Energy Conservation Standards for Residential Dehumidifiers	DOE, EPCA etc.	80 Fed. Reg. 31,645 (proposed June 3, 2015); 81 Fed. Reg. 38,337 (finalized June 13, 2016) RIN 1904-AC81	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Residential Conventional Ovens	DOE, EPCA etc.	80 Fed. Reg. 33,029 (proposed June 10, 2015) RIN 1904-AD15	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Commercial Prerinse Spray Valves	DOE, EPCA etc.	80 Fed. Reg. 39,485 (proposed July 9, 2015); 81 Fed. Reg. 4747 (finalized Jan. 27, 2016) RIN 1904-AD31	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
GHG and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, Phase 2 & DOT's environmental impact statement	EPA, CAA; DOT, EPCA etc. & NEPA	80 Fed. Reg. 40,137 (proposed July 13, 2015) RIN 2060-AS16; RIN 2127-AL52	Global only
Pipeline Safety: Expanding the Use of Excess Flow Valves in Gas Distribution Systems to Applications Other than Single-Family Residences	DOT, Natural Gas Pipeline Safety Act, amended by Pipeline Safety, Job Creation, and Regulatory Certainty Act	80 Fed. Reg. 41,460 (proposed July 15, 2015) RIN 2137-AE71	Global only, in the regulatory impact analysis's sensitivity analysis
Energy Conservation Standards for Ceiling Fan Light Kits	DOE, EPCA etc.	80 Fed. Reg. 48,623 (proposed Aug. 13, 2015); 81 Fed. Reg. 579 (finalized Jan. 6, 2016) RIN 1904-AC87	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global

Energy Conservation Standards for Refrigerated Bottled or Canned Beverage Vending Machines	DOE, EPCA etc.	80 Fed. Reg. 50,461 (proposed Aug. 19, 2015); 81 Fed. Reg. 1027 (finalized Jan. 8, 2016) RIN 1904-AD00	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills	EPA, CAA	80 Fed. Reg. 52099 (proposed Aug. 27, 2015) RIN 2060-AS23	Global only
NSPS for Municipal Solid Waste Landfills	EPA, CAA	80 Fed. Reg. 52,162 (proposed Aug. 27, 2015) RIN 2060-AM08	Global only
Energy Conservation Standards for Battery Chargers	DOE, EPCA etc.	80 Fed. Reg. 52,849 (proposed Sept. 1, 2015); 81 Fed. Reg. 38,265 (finalized June 13, 2016) RIN 1904-AB57	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
NSPS for Oil and Natural Gas Sector	EPA, CAA	80 Fed. Reg. 56,593 (proposed Sept. 18, 2015); 81 Fed. Reg. 35,823 (finalized June 3, 2016) RIN 2060-AS30	Global only
Federal Plan for GHG from EGUs	EPA, CAA	80 Fed. Reg. 64,965 (proposed Oct. 23, 2015) RIN 2060-AS47	Global only

Roadless Area Conservation in Colorado & the Supplemental Environmental Impact Statement	USDA (Forest Service), NEPA	80 Fed. Reg. 72,665 (proposed Nov. 20, 2015) RIN 0596-AD26	Domestic and global disbenefits presented equally, along with forest-boundary estimate, with decision seemingly made on the basis of the domestic estimate
Cross-State Air Pollution Rule Update for the 2008 Ozone NAAQS	EPA, CAA	80 Fed. Reg. 75,705 (proposed Dec. 3, 2015) RIN 2060-AS05	Global only
Energy Conservation Standards for Ceiling Fans	DOE, EPCA etc.	81 Fed. Reg. 1687 (proposed Jan. 13, 2016) RIN 1904-AD28	Domestic discussed in preamble Separate tables of domestic and global in TSD, though emphasis on global
Waste Prevention, Production Subject to Royalties, and Resource Conservation & accompanying regulatory impact analysis and environmental assessment	DOI, Mineral Leasing Act, Federal Land Policy & Mgmt. Act, etc., NEPA	81 Fed. Reg. 6615 (proposed Feb. 8, 2016) RIN 1004-AE14	Global only
Energy Conservation Standards for General Service Lamps	DOE, EPCA etc.	81 Fed. Reg. 14,527 (proposed Mar. 17, 2016) RIN 1904-AD09	Domestic discussed in preamble, and Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Commercial Packaged Boilers	DOE, EPCA etc.	81 Fed. Reg. 15,836 (proposed Mar. 24, 2016) RIN 1904-AD01	Domestic discussed in preamble, and Separate tables of domestic and global in TSD, though emphasis on global

Pipeline Safety: Safety of Gas Transmission and Gathering Pipelines	DOT, Natural Gas Pipeline Safety Act	81 Fed. Reg. 20,722 (proposed Apr. 8, 2016) RIN 2137-AE72	Global only, in regulatory impact analysis
Energy Conservation Standards for Compressors	DOE, EPCA etc.	81 Fed. Reg. 31,679 (proposed May 19, 2016) RIN 1904-AC83	Domestic discussed in preamble, and Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Commercial Water Heating Equipment	DOE, EPCA etc.	81 Fed. Reg. 34,439 (proposed May 31, 2016) RIN 1904-AD34	Domestic discussed in preamble, and Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Portable Air Conditioners	DOE, EPCA etc.	81 Fed. Reg. 38,397 (proposed June 13, 2016) RIN 1904-AD02	Domestic discussed in preamble, and Separate tables of domestic and global in TSD, though emphasis on global
Energy Conservation Standards for Manufactured Housing	DOE, EPCA etc.	81 Fed. Reg. 39,755 (proposed June 17, 2016) RIN 1904-AC11	Domestic discussed in preamble, and Separate tables of domestic and global in TSD, though emphasis on global

Appendix B: Carbon Valuation Around the World

Jurisdiction/Entity	**Valuation Label**	**Source/Year Adopted**	**Value per tCO_2e (in 2016 USD)**[265]	**Is Value > Domestic-Only SCC** (Country's % World GDP[266] * U.S. SCC)**?**
Sweden (also has carbon tax and part of EU-ETS)	"Valuation of carbon dioxide"[267]	Swedish Transp. Admin.'s *Economic Principles and Estimates for the Transportation Section* (2012)[268]	**$168**, central value for emissions from long-term investments[269]	Yes (0.41% of $59 =$0.24)
Germany (also part of EU-ETS)	"Climate Cost"	Recommendations by the Federal Environment Agency on *Environmental Costs in the Energy and Transport Sectors* (2014)[270]	**$167**, average value for 2030 emissions[271]	Yes (3.45% of $59=$2)

[265] Note: taxes and trading systems may not cover all economic sectors.

[266] *GDP as Share of World GDP at PPP by Country*, QUANDL, https://www.quandl.com/collections/economics/gdp-as-share-of-world-gdp-at-ppp-by-country [https://perma.cc/T25H-RXWB] (last visited Jan. 24, 2017); *Gross Domestic Product 2015, PPP*, WORLD DEVELOPMENT INDICATORS DATABASE (Dec. 16, 2016), http://databank.worldbank.org/data/download/GDP_PPP.pdf [https://perma.cc/NLH7-SC3Q].

[267] SIKA, SUMMARY OF ASEK ESTIMATES, SIKA REPORT 2000:3, at 13 (2000), http://trafa.se/globalassets/sika/sika-rapport/sr_2000_3en.pdf [https://perma.cc/EQ9B-GEND] [hereinafter SIKA REPORT].

[268] NORWEGIAN MINISTRY OF FIN., COST-BENEFIT ANALYSIS, OFFICIAL NORWEGIAN REPORTS NOU 2012:16 145 (2012), https://www.regjeringen.no/contentassets/5fce956d51364811b8547eebdbcde52c/en-gb/pdfs/nou201220120016000en_pdfs.pdf [https://perma.cc/8Y4W-4H7E].

[269] The value reported for long-term investments as SEK 1450 (for sensitivity analysis, a SEK 3500 value is recommended), presumably in 2012 SEK, was based on the publication date of the transportation sector guidelines. Inflating to 2016 SEK, based on the Statistics Sweden inflation index, gives SEK 1450.81. Converting that to March 2016 USD, using Google Finance, gives $168.13, which we round to $168. *See also* SIKA REPORT, *supra* note 267, at 13 (suggesting a value of SEK 1.5 per kilogram of carbon dioxide, which would equal about SEK 1361 per ton of carbon dioxide).

[270] UMWELTBUNDESAMT, ENVIRONMENTAL COSTS IN THE ENERGY AND TRANSPORT SECTORS: RECOMMENDATIONS BY THE FEDERAL ENVIRONMENT AGENCY (2013), http://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/hgp_umweltkosten_en.pdf [https://perma.cc/9FSE-BWZG].

[271] Minimum (€70), average (€145), and maximum (€215) values are given for 2030 emissions, in 2010€. Inflating the average value to 2016 EUR, using the Eurostat index, gives

Sweden (also part of EU-ETS and has analytic metric)	Carbon tax	Adopted 1991	**$130**[272]	Yes (0.41% of $43=$0.17)
United Kingdom (also has carbon tax and part of EU-ETS[273])	"Shadow price of carbon"[274]	*Carbon Valuation in UK Policy Appraisal*, Dep't of Energy and Climate Change (2009, 2015)[275]	**$115**, central value for 2030 non-traded emissions[276]	Yes (2.36% of $59=$1.4)
France (also part of EU-ETS)	Carbon tax	Adopted 2014	**$110** for 2030 emissions (currently $24)[277]	Yes (2.39% of $59=$1.4)
Norway (also part of EU-ETS and has carbon tax)	"Global marginal social cost of carbon"	Recommendations of Ministry of Finance on *Cost-Benefit Analysis* (2012), citing to the carbon price used in cost-benefit analyses by Norwegian Pub. Roads Admin.[278]	**$104** for 2030 non-traded emissions[279]	Yes (0.32% of $59=$0.19)

€153.7. Converting that to March 2016 USD, based on Google Finance, gives $166.58, which we round to $167.

[272] WORLD BANK GRP. ET AL., STATE AND TRENDS OF CARBON PRICING (2015), http://documents.worldbank.org/curated/en/636161467995665933/pdf/99533-REVISED-PUB-P153405-Box393205B.pdf [https://perma.cc/6XBB-FSBB]; SVEBIO, CARBON TAX—KEY INSTRUMENT FOR ENERGY TRANSITION, https://www.svebio.se/sites/default/files/Carbon%20tax%20paper_COP21.pdf [https://perma.cc/A3YK-9ZZ4] (last visited Jan. 28, 2017).

[273] UK participation in the EU-ETS may depend on the Brexit negotiations.

[274] *Carbon Valuation*, GOV.UK, https://www.gov.uk/government/collections/carbon-valuation–2#shadow-price-of-carbon [https://perma.cc/XCV4-X849] (last updated Nov. 18, 2015).

[275] U.K. DEP'T OF ENERGY & CLIMATE CHANGE, UPDATED SHORT-TERM TRADED CARBON VALUES USED FOR UK PUBLIC POLICY APPRAISAL tbl.1 (2015), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/477540/Updated_short-term_traded_carbon_values_used_for_UK_policy_appraisal__2015_.pdf [https://perma.cc/9GZM-A7UL]; U.K DEP'T OF ENERGY & CLIMATE CHANGE, A BRIEF GUIDE TO THE CARBON VALUATION METHODOLOGY FOR UK POLICY APPRAISAL tbl.1 (2011), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48184/3136-guide-carbon-valuation-methodology.pdf [https://perma.cc/ZUR6-WEMM].

[276] 2030 emission values are given for both emissions covered and emissions not covered by ETS: £37 (low), £74 (central), £111 (high), in 2011 EUR. Inflating the central, non-traded value to 2016£, using the U.K. Office for National Statistics Index, gives £81.66. Converting that to March 2016 USD, based on Google Finance, gives $114.85, which we round to $115.

[277] WORLD BANK GRP. ET AL., *supra* note 272.

[278] NORWEGIAN MINISTRY OF FIN., *supra* note 268, at 141, 145, 148.

Switzerland (also has Emissions Trading System)	Carbon tax	Adopted 2008	**$87** currently, rising to maximum of $125, based on emissions trajectory[280]	Yes (0.44% of $43=$0.19)
United States—Washington State	Social Cost of Carbon	Washington State Energy Office *Recommendation for Standardizing the Social Cost of Carbon when Used for Public Decision-Making Processes* (2014)	**$86** central value for 2030 emissions (follow federal SCC, but focus on 2.5% discount rate values, rather than 3% discount rate)[281]	n/a
Various Corporations	Internal shadow prices	See CDP report[282]	As high as **$80** (Exxon) and as low as **$6** (Microsoft)	n/a
Finland (also part of EU-ETS)	Carbon tax	Adopted 1990	**$64** for transport fuels, $48 for heating fuels[283]	Yes (0.2% of $43=$0.9)
United States (also has sub-national SCC use and cap-and-trade systems)	Social Cost of Carbon	Interagency Working Group *Technical Support Document on the Social Cost of Carbon* (2013)[284]	**$59**, central value for 2030 emissions[285] ($43 for 2015 emissions, $49 for 2020 emissions, and $55 for 2025 emissions)	Yes (16.14% of $59=$9.5)

[279] NOK 800 is the fixed unit price given for emissions starting in the year 2030. We assume that value is given in 2009 NOK, based on the 2009 publication date of the Climate Cure assessment of future allowance prices. Inflating from 2009 NOK to 2016 NOK, using the Statistics Norway inflation index, gives NOK 899.92. Converting that to March 2016 USD, using Google Finance, gives $103.54, which we round to $104.

[280] WORLD BANK GRP. ET AL., *supra* note 272.

[281] $75, inflated from 2007 USD to 2016 USD. WASH. STATE ENERGY OFFICE, RECOMMENDATIONS FOR STANDARDIZING THE SOCIAL COST OF CARBON WHEN USED FOR PUBLIC DECISION-MAKING PROCESSES, at 3 (2014), http://www.commerce.wa.gov/wp-content/uploads/2015/11/Energy-EV-Planning-Social-Cost-of-Carbon-Sept-2014.pdf [https://perma.cc/DR38-WVSV] (explaining "why we recommend using a 2.5% discount rate").

[282] CDP, GLOBAL CORPORATE USE OF CARBON PRICING: DISCLOSURES TO INVESTORS (2014), http://southasia.oneworld.net/Files/carbon-pricing-report [https://perma.cc/SBX5-67LA]; *see also* WORLD BANK GRP. ET AL., *supra* note 272.

[283] WORLD BANK GRP. ET AL., *supra* note 272.

[284] 2013 TSD, *supra* note 42.

United States—Minnesota	Social cost of carbon	Minnesota Public Utilities Commission recommendation for use in solar valuation	**$59**, central value for 2030 emissions (copied the federal SCC)	n/a
United States—Maine	Social cost of carbon	Maine Public Utilities Commission recommendation for use in solar valuation[286]	**$59**, central value for 2030 emissions (copied the federal SCC)	n/a
United States—New York	Social cost of carbon	New York Public Services Commission[287]	**$59**	n/a
Canada (also has sub-national taxes and cap-and-trade systems, and Prime Minister recently pledged future national carbon tax[288])	Social cost of carbon	Pledged to "align" SCC with United States;[289] history of using the U.S. interagency working group numbers[290]	**$59**, central value for 2030 emissions[291]	Yes (1.48% of $59=$0.9)
Mexico	Social cost of carbon	Pledged to "align" SCC with United States[292]	**$59**, presumed central value for 2030 emissions	Yes (1.98% of $59=$1.17

[285] *Id.* 3% discount rate value for 2030 emissions, inflated from 2007 USD to 2016 USD using the Bureau of Labor Statistics' ("BLS") inflation index.

[286] ME. PUB. UTIL. COMM'N, MAINE DISTRIBUTED SOLAR VALUATION STUDY (2015).

[287] N.Y. STATE DEP'T OF PUB. SERV., ORDER ADOPTING A CLEAN ENERGY STANDARD (2016).

[288] Jean Chemnick, *Canada to Impose a National Carbon Price*, E&E NEWS (July 21, 2016), http://www.eenews.net/climatewire/2016/07/21/stories/1060040581 [https://perma.cc/74QN-9LBU]**.**

[289] White House Office of the Press Sec'y, *supra* note 72 ("Canada and the U.S. will align approaches, reflecting the best available science for accounting for the broad costs to society of the GHG emissions that will be avoided by mitigation measures, including using similar values for the social cost of carbon and other GHGs for assessing the benefits of regulatory measures.").

[290] *See* Order Declaring that the Reductions of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations Do Not Apply in Nova Scotia, SOR/2014-265 (Can.).

[291] Canada has used the U.S. interagency working group estimates from the 2010 technical support document, focusing on the 3% discount rate value, though also considering the ninety-fifth percentile value for sensitivity. *See id.*; *see also* 2010 TSD, *supra* note 4. Inflating the 2010 technical support document values to 2016 USD, based on the BLS inflation index, gives a central estimate for 2030 emissions of $37.48, which we round to $37.

[292] Furman & Deese, *supra* note 72 (summarizing the North American Leader's Summit announcement that the United States, Canada, and Mexico would "align" their SCC estimates).

European Union—European Investment Bank	"Value of carbon"	*Economic Appraisal of Investment Projects at the EIB* (2013)[293]	**$57**, central value for 2030 emissions[294]	Yes (17% of $59=$10)
European Union—HEATCO Project	"Shadow Prices"	*Developing Harmonised European Approaches for Transport Costing and Project Assessment* (2006)[295]	**$55**, central value for 2030 emissions[296]	Yes (17% of $59=$10)
European Union—European Commission (also manages EU-ETS)	"Social cost of carbon"[297]	EU-ETS Impact Assessment (2008)[298]	**$52** for 2020 emissions[299]	Yes (17% of $59=$10)
Norway (also part of EU-ETS and has analytic metric)	Carbon tax	Adopted 1991	**$52** for natural gas and petrol; as low as $3 for some fuels[300]	Yes (0.32% of $43=$0.14)

[293] EUR. INV. BANK, THE ECONOMIC APPRAISAL OF INVESTMENT PROJECTS AT THE EIB 251 (2013).

[294] Values are given for 2010 emissions, with annual adders. 2030 emissions are valued at €20 (low), €45 (central), €80 (high) per tCO2e, in 2006 EUR. Inflating the central value to 2016 EUR, using the Eurostat index, gives €52.5. Converting that to March 2016 USD, based on Google Finance, gives $56.87, which we round to $57.

[295] PETER BICKEL ET. AL., HEATCO DELIVERABLE 5 PROPOSAL FOR HARMONISED GUIDELINES (2006), http://heatco.ier.uni-stuttgart.de/HEATCO_D5_summary.pdf [https://perma.cc/EV5Q-YLR3].

[296] Values are given for 2030 emissions: €26 (low), €40 (central), €103 (upper), in 2002€. Inflating the central value to 2016 EUR, using the Eurostat index, gives €50.92. Converting that to March 2016 USD, based on Google Finance, gives $55.24, which we round to $55.

[297] *Science for Environment Policy: The Economic Benefits of Carbon Storage in the Mediterranean Sea*, EUR. COMM'N DG ENV'T NEWS ALERT SERV. (July 23, 2015), http://ec.europa.eu/environment/integration/research/newsalert/pdf/economic_benefits_carbon_storage_in_mediterranean_sea_422na3_en.pdf [https://perma.cc/5VF4-T5K5] (referring to "European Commission estimates of the social cost of carbon emissions").

[298] *See* U.K. DEP'T OF ENERGY & CLIMATE CHANGE, CARBON VALUATION IN UK POLICY APPRAISAL: A REVISED APPROACH, at 42 (2009); *see also* EUR. COMM'N, SEC(2008) 85, IMPACT ASSESSMENT ACCOMPANYING THE PACKAGE OF IMPLEMENTATION MEASURES FOR THE EU'S OBJECTIVES ON CLIMATE CHANGE AND RENEWABLE ENERGY FOR 2020, at 24 (2008) (listing 39 euro/tCO2 as carbon price for both ETS and non-ETS).

[299] €40 value is given for 2020 emissions, in 2005 EUR. Inflating to 2016 EUR, using the Eurostat index, gives €47.71. Converting that to March 2016 USD, based on Google Finance, gives $51.70, which we round to $52.

United Kingdom (also part of EU-ETS and has analytic metric)	"Carbon price floor" (a tax)	Adopted 2013	**$50**, projected price for 2020 emissions[301] (currently $28[302])	Yes (2.36% of $49=$1.16)
Japan—Tokyo (Japan also has a carbon tax)	Cap and trade	Adopted 2010	**$36** (price as of 2015)[303]	Yes (4.4%* of $43=$1.9) [*Japan's GDP share]
International Monetary Fund	"Damages from global warming"	Recommendation for corrective carbon tax (2013), based on U.S. Interagency Working Group's 2010 Technical Support Document[304]	**$27**, value given without emissions year[305]	n/a
Canada—Alberta	Carbon tax	Adopted 2015[306]	**$28** for 2030 emissions[307]	n/a

[300] WORLD BANK GRP. ET AL., *supra* note 272; *see also* Annegrete Bruvoll and Hanne Marit Dalen, *Pricing of CO2 Emissions in Norway*, STATISTICS NOR. (2009), https://www.ssb.no/a/english/publikasjoner/pdf/doc_200916_en/doc_200916_en.pdf.

[301] £30 in 2009 prices for year 2020 inflates to £35.32, converts to $49.71, and rounds to $50. *UK Carbon Price Floor and Carbon Price Support Mechanism*, SCOTTISH GOV'T, http://www.gov.scot/Topics/Environment/climatechange/ukandeuclimatechange/Carbon-Price-Floor (last updated Apr. 15, 2015); Dep't of Energy & Climate Change, *Overview of UK Carbon Pricing Policies*, PARTNERSHIP FOR MKT. READINESS (2015), https://www.thepmr.org/system/files/documents/United%20Kingdom-%20Overview%20of%20Domestic%20Carbon%20Pricing%20Policies.pdf [https://perma.cc/GHP4-ADES].

[302] WORLD BANK GRP. ET AL., *supra* note 272.

[303] *Id.*

[304] INT'L MONETARY FUND, ENERGY SUBSIDY REFORM: LESSONS AND IMPLICATIONS 45 (2013).

[305] $25 value given in 2010 USD, claiming to follow the U.S. interagency working group's 2010 technical support document. Inflated to 2016 USD using the BLS inflation index.

[306] *Carbon Levy and Rebates,* GOV'T OF ALTA., http://www.alberta.ca/climate-carbon-pricing.cfm (last visited Feb. 19, 2017).

[307] Tax set at 30 CAN for 2018 emission, rising at inflation plus two percent after that. Trevor Tombe, *Here's What We Know—And Don't Know—About Alberta's Carbon Tax,* MACLEAN'S (Nov. 23, 2015), http://www.macleans.ca/economy/economicanalysis/heres-what-we-know-and-dont-know-about-albertas-carbon-tax [https://perma.cc/MHS3-BP46]; *Carbon Levy and Rebates, supra* note 306. Ignoring the inflation adjuster, a two percent increase per year would price 2030 emissions at 38 CAN. Converting to March 2016 USD, based on Google Finance, gives $28.28, which we round to $28.

Denmark (also part of EU-ETS)	Carbon tax	Adopted 1992	**$25**[308]	Yes (0.23% of $43=$0.1)
Canada—British Columbia	Carbon tax	Adopted 2008[309]	**$23** currently[310]	n/a
Ireland (also part of EU-ETS)	Carbon tax	Adopted 2010	**$22**[311]	Yes (0.21% of $43=$0.09)
Slovenia	Carbon tax	Adopted 1996	**$19**[312]	Yes (0.06% of $43=$0.03)
Costa Rica	Fossil fuel tax (3.5% of market value)	Adopted 1997[313]	Equivalent of about $1 to **$14** per tCO2e	Yes (0.07% of $43=$0.03)
Canada—Quebec	Cap and trade	Implemented 2013	**$13** (price as of 2015)[314]	n/a
United States—California	Cap and trade	Assembly Bill (AB) 32, implemented 2013[315]	**$13** (average price as of May 2016[316])	n/a
New Zealand	Emissions Trading System	Adopted 2008	**$12.5** (price as of June 2016)[317]	Yes (0.15% of $43=$0.06)

[308] WORLD BANK GRP. ET AL., *supra* note 272.
[309] *See* WORLD BANK, PUTTING A PRICE ON CARBON WITH A TAX (2014).
[310] *See* WORLD BANK GRP. ET AL., *supra* note 272; *How the Carbon Tax Works,* B.C. MINISTRY OF FIN., http://www.fin.gov.bc.ca/tbs/tp/climate/A4.htm (last visited Feb. 19, 2017).
[311] *Id.*
[312] WORLD BANK GRP. ET AL., *supra* note 272.
[313] *Carbon Pricing as of 2014*, SIGHTLINE INST., http://sightline.wpengine.netdna-cdn.com/wp-content/uploads/2014/11/global-carbon-programs-map-still-111714.png [https://perma.cc/EW78-CNFT] (last visited Feb. 19, 2017).
[314] WORLD BANK GRP. ET AL., *supra* note 272; *see also* QUE. MINISTRY OF SUSTAINABLE DEV., ENV'T & PARKS, THE QUÉBEC CAP-AND-TRADE SYSTEM FOR GREENHOUSE GAS EMISSION ALLOWANCES: FREQUENTLY ASKED QUESTIONS (2014) (noting a $10 floor in 2012, with the floor rising 5% per year).
[315] CAL. ENVTL. PROT. AGENCY, ARB EMISSIONS TRADING PROGRAM (2015).
[316] CAL. AIR RES. BD., MAY 2016 JOINT AUCTION #7 SUMMARY RESULTS REPORT, at 4 (2016).

Switzerland (also has carbon tax)	Emissions trading system	Adopted 2008[318]	**$12** (price as of 2015)[319]	Yes (0.44% of $43=$0.19)
European Union (various members have taxes; EU also uses SCC estimates)	Emissions Trading System	Implemented in 2005[320]	**$9** (price as of August 2015)[321]	Yes (17% of $43=$7.3)
South Korea	Emissions Trading System	Adopted 2015	**$9** (price as of 2015)[322]	Yes (1.65% of $43=$0.7)
Iceland (also part of EU-ETS)	Carbon tax	Adopted 2010	**$8**[323]	Yes (0.01% of $43=$0.004)
South Africa	Carbon tax	Anticipated to Take Effect in January 2017[324]	**$8** (R120)	Yes (0.65% of $43=$0.28)
United States—RGGI States	Cap and trade	Implemented 2009[325]	**$8** clearing price as of December 2015[326]	n/a

[317] INT'L CARBON ACTION P'SHIP, NEW ZEALAND EMISSIONS TRADING SCHEME, at 2 (2016), https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=48 [https://perma.cc/VD7Y-QJQJ].

[318] WORLD BANK, *supra* note 309.

[319] WORLD BANK GRP. ET AL., *supra* note 272.

[320] EURO. COMM'N, THE EU EMISSIONS TRADING SYSTEM (EU ETS) (2016), https://ec.europa.eu/clima/sites/clima/files/factsheet_ets_en.pdf [https://perma.cc/MV5R-UZT2].

[321] WORLD BANK GRP. ET AL., *supra* note 272.

[322] *Id.*

[323] *Id.*

[324] Mike Szabo, *South African Government to Revise Carbon Tax Bill Following Consultation*, CARBON PULSE (Feb. 25, 2016), http://carbon-pulse.com/16167 [https://perma.cc/X8Q4-YKSN].

[325] *About the Regional Greenhouse Gas Initiative (RGGI)*, REGIONAL GREENHOUSE GAS INITIATIVE, https://www.rggi.org/docs/Documents/RGGI_Fact_Sheet.pdf [https://perma.cc/H2FK-BQK8] (last visited Jan. 27, 2017).

[326] *Auction Results*, REGIONAL GREENHOUSE GAS INITIATIVE, https://www.rggi.org/market/co2_auctions/results [https://perma.cc/NU2D-N99U] (last visited Jan. 27, 2017). This converts to $8.3 per metric ton, which we round to $8. WORLD BANK GRP. ET AL., *supra* note 272.

United States—Boulder, Colorado	Carbon tax	Adopted 2007	Approximately **$7**[327] (up to 0.5 cents per kilowatt-hour[328])	n/a
China—Beijing, Shenzhen, Hubei, Guangdong, Chongqing, Tianjin	Pilot Emissions Trading System	Adopted 2013	$2 to **$7** (prices vary across cities)[329]	No (16.32%* of $43=$7) [*China's GDP share]
Chile	Carbon tax	Effective 2017	**$5**[330]	Yes (0.38% of $49=$0.19)
Portugal (also part of EU-ETS)	Carbon tax	Adopted 2015	**$5**[331]	Yes (0.26% of $43=$0.11)
Latvia (also part of EU-ETS)	Carbon tax	Adopted 1995	**$4**[332]	Yes (0.04% of $43=$0.02)
Japan (also has sub-national cap-and-trade systems)	Carbon tax	Adopted 2012	**$2**[333]	Not significantly greater (4.4% of $49=$2.2)

[327] *States,* CARBON TAX CTR., http://www.carbontax.org/states/#Boulder [https://perma.cc/BUW3-EE8T] (last visited Jan. 27, 2017).
[328] *Climate Action Tax: Frequently Asked Questions: How Much Do I Pay for CAP Tax?*, CITY OF BOULDER, COLO., https://bouldercolorado.gov/climate/climate-action-plan-cap-tax [https://perma.cc/XR2M-W66R] (last visited Jan. 27, 2017).
[329] WORLD BANK GRP. ET AL., *supra* note 272.
[330] *Id.*
[331] *Id.*
[332] *Id.*
[333] *Id.*; *Japan Introduces New Tax on Carbon Emissions,* JAPAN FOR SUSTAINABILITY (Jan. 4, 2013), http://www.japanfs.org/en/news/archives/news_id032490.html [https://perma.cc/9R8E-GGLU] (289 yen); *Carbon Tax: Japan*, INT'L ENERGY AGENCY, http://www.iea.org/policiesandmeasures/pams/japan/name-139284-en.php [https://perma.cc/WK73-QSFB] (last visited Jan. 24, 2017).

Mexico (also calculates global benefits in regulatory impact analyses)	Carbon tax	Adopted 2012	$1 to **$3**, depending on fuel type[334]	Yes (1.98% of $43=$0.85)
Kazakhstan	Emissions Trading System	Adopted 2013	**$2** (average price as of 2014)[335]	Yes (0.39% of $43=$0.17)
Estonia (also part of EU-ETS)	Carbon tax	Adopted 2000	**$2**	Yes (0.03% of $43=$0.01)
India	Coal tax (INR 50 per ton of coal)	Adopted 2010	About **$2** per tCO2 (also claims an implicit carbon tax on petrol of $140 per tCO2)[336]	No (6.83% of $43=$2.7)
Poland (also part of EU-ETS)	Carbon tax	Adopted 1990	<$1[337]	Uncertain (0.88% of $43=$0.38)
Thailand	Vehicle tax based on CO_2 emissions[338]	Effective 2016[339]	>$0 (tax based on car price, difficult to convert to price per tCO2e)	Uncertain

[334] Mike Szabo, *Mexico to Launch Carbon Offset Trading in 2017, Will Pursue Link to WCI Markets*, CARBON PULSE (July 9, 2015), http://carbon-pulse.com/6143/ [https://perma.cc/WR8X-GTL5]; WORLD BANK GRP. ET AL., *supra* note 272.

[335] WORLD BANK GRP. ET AL., *supra* note 272.

[336] *India's Intended Nationally Determined Contribution: Working Towards Climate Justice* at 27, U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE (Oct. 1, 2015), http://www4.unfccc.int/submissions/INDC/Published%20Documents/India/1/INDIA%20INDC%20TO%20UNFCCC.pdf [https://perma.cc/82DQ-RWKR].

[337] WORLD BANK GRP. ET AL., *supra* note 272.

[338] THAILAND EXCISE DEPT., THAILAND'S AUTOMOTIVE EXCISE TAX REFORM (2014), http://transportandclimatechange.org/wp-content/uploads/2015/01/Thailands-Automotive-Excise-Tax-Reform.pdf [https://perma.cc/W9FB-68JW].

[339] *Thailand's Intended Nationally Determined Contribution (INDC)* at 3, U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE (Oct. 1, 2015), http://www4.unfccc.int/submissions/INDC/Published%20Documents/Thailand/1/Thailand_INDC.pdf [https://perma.cc/NX97-RF8D].