Carbonated Fodder: The Social Cost of Carbon in Canadian and U.S. Regulatory Decision-Making

DAVID V. WRIGHT*

ABSTRACT

For decades, cost-benefit analysis has been criticized while it has simultaneously been a core analytical tool in regulatory decision-making. Scrutiny of a relatively new component of cost-benefit analysis used to measure environmental benefits—the "social cost of carbon" ("SCC")—provides fresh evidence that confirms long-standing concerns around bias, manipulation, uncertainty, and moral judgment. This Article is the first to examine and compare use of the social cost of carbon in Canadian and U.S. carbon emissions regulatory decision-making. It reveals that despite fundamental differences between the two countries, regulators on either side of the border use similar or identical dollar values and modeling. This practice erroneously assumes commonalities across the two countries that have not been empirically proven, including with respect to risk tolerance, moral judgment, value of ecosystem services, and the value of a human life. Additionally, the analysis finds differences in the way SCC values are selected and used by Canadian and U.S. decision-makers, demonstrating that another example of cost-benefit analysis is susceptible to bias and arbitrary decisions. This in turn undermines the credibility of regulatory decisions in the carbon emissions realm at a critical time in global climate governance. The Article goes on to suggest that SCC represents an opportunity for cost-benefit analysis to evolve and contribute to sound regulatory decision-making, but further improvement is needed to do so.

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* Assistant Professor of Law, University of Calgary (commencing January 2018), LL.M., Stanford Law School; J.D., Schulich School of Law; M.A., Dalhousie University. This paper was developed as part of the 2015–16 Environmental Law & Policy Colloquium at Stanford Law School. Sincere thanks to Professor Vanessa Casado-Perez and Professor Buzz Thompson for helpful insights and comments during development of this article. Any errors are the author's alone.

"All Models are wrong, but some are useful."

—George E. P. Box[1]

INTRODUCTION

For nearly two decades, Canada and the United States have followed similar approaches in pursuing greenhouse gas ("GHG") emission reductions, both in terms of targets and implementation.[2] Today, the federal governments in both countries are using sector-based regulation as a primary tool to achieve emission reductions, largely due to an inability or unwillingness to put in place comprehensive market-based regimes at the federal level. While most policy-makers view national cap-and-trade or carbon tax regimes as the more economically efficient means of correcting the market failure that is climate change,[3] the regulatory

1. GEORGE BOX & NORMAN DRAPER, EMPIRICAL MODEL-BUILDING AND RESPONSE SURFACES 424 (1987).

2. NAT'L ROUND TABLE ON THE ENV'T & THE ECON., PARALLEL PATHS: CANADA-U.S. CLIMATE POLICY CHOICES, 15 (2011) http://nrt-trn.ca/wp-content/uploads/2011/08/canada-us-report-eng.pdf; *see also* David McLaughlin, *Same Song, Different Harmony: Canada-US Climate Policy*, POL'Y MAG. (2014), http://policymagazine.ca/pdf/9/PolicyMagazineSeptember-October-14Mclaughlin.pdf. Targets under the 1997 Kyoto Protocol are the clearest early example. Canada's target was a 6% reduction below 1990 levels in the 2008–2012 compliance period, and the U.S. target was 7% in the same period. *Kyoto Protocol*, UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (2014), http://unfccc.int/kyoto_protocol/items/3145.php. While Canada ratified that treaty and the U.S. did not, approaches to reducing emissions remained similar in ensuing years.

3. *See* Cary Coglianese & Jocelyn D'Ambrosio, *Policymaking Under Pressure: The Perils of Incremental Responses to Climate Change*, 40 CONN. L. REV. 1411, 1429 (2008); *see also* Valentina Bosetti & David G. Victor, *Politics and Economics of Second-Best Regulation of Greenhouse Gases: The Importance of Regulatory Credibility*, 32 ENERGY J. 1, 19 (2011). For a succinct and accessible description of climate change as a market failure, see Alex Bowen, Simon Dietz & Naomi Hicks, *Why do Economists Describe Climate Change as a 'Market Failure'?*, THE GUARDIAN (May 21, 2012, 10:24 AM), http://www.theguardian.com/environment/2012/

approach has been the reality on both sides of the border. The importance of this approach at this moment is significant. Both countries chiefly rely on implementation of GHG emission reduction regulations as the basis for achieving their recently formalized "Nationally Determined Contributions" under the new Paris Agreement on climate change;[4] and, of course, dangerous climate change impacts are now observable around the world and forecasted to intensify.[5]

Core to the regulatory approach in both countries is use of cost-benefit analysis ("CBA") during the regulatory development process.[6] Likewise, in both countries the CBA for carbon emission[7] regulations places calculation of the social cost of carbon ("SCC") front and center.[8] The SCC is an estimated dollar figure representing the value of damages avoided for a unit of carbon emission reductions.[9] Monetized values of carbon emission reductions generated through SCC can have a significant impact on regulatory decisions and, ultimately, actual mitigation of the future impacts of climate change.[10]

may/21/economists-climate-change-market-failure ("Unregulated markets have overproduced CO_2 because the costs are not priced into the transaction.").

4. CANADA, INTENDED NATIONALLY DETERMINED CONTRIBUTION SUBMISSION TO THE UNFCCC (2015), http://www4.unfccc.int/submissions/INDC/Published%20Documents/Canada/1/INDC%20-%20Canada%20-%20English.pdf; UNITED STATES OF AMERICA, INTENDED NATIONALLY DETERMINED CONTRIBUTION SUBMISSION TO THE UNFCCC (2015), http://www4.unfccc.int/submissions/INDC/Published%20Documents/United%20States%20of%20America/1/U.S.%20Cover%20Note%20INDC%20and%20Accompanying%20Information.pdf.

5. *See* C.B. FIELD ET AL., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, SUMMARY FOR POLICY MAKERS: CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY (2014), http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf (providing a detailed view of impacts across the globe); *see also* JERRY MELILLO ET AL., U.S. GLOBAL CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT (2014), http://nca2014.globalchange.gov (providing a detailed view of impacts in the U.S.).

6. *See infra* sections I.B & C.

7. The terms "carbon emissions" and "CO_2 emissions" are used interchangeably throughout this Article. Both refer to the greenhouse gas that is carbon dioxide. Note that social cost of carbon deals with the greenhouse gas of carbon dioxide specifically. However, early work is underway with respect to other GHGs. For example, a methodology for the "social cost of methane" is in development. *See* ENV'T & CLIMATE CHANGE CAN., TECHNICAL UPDATE TO ENVIRONMENT AND CLIMATE CHANGE CANADA'S SOCIAL COST OF GREENHOUSE GAS ESTIMATES 14 (2016) [hereinafter ECCC TECHNICAL DOCUMENT]. Note that methane was an important dimension in the U.S.-Canada Joint Statement on Climate, Energy, and Arctic Leadership released in early 2016. *See* OFFICE OF THE PRESS SECRETARY, THE WHITE HOUSE, *U.S.-Canada Joint Statement on Climate, Energy, and Arctic Leadership* (Mar. 10, 2016), https://obamawhitehouse.archives.gov/the-press-office/2016/03/10/us-canada-joint-statement-climate-energy-and-arctic-leadership.

8. *Infra* sections I.B & I.C.

9. For a more detailed definition and discussion, see *infra* section I.A.

10. *See* William Pizer et al., *Using and Improving the Social Cost of Carbon*, 346 SCI. 1189, 1189–1190 (2014); Richard Revesz et al., *Improve Economic Models of Climate Change*, 508 NATURE 173 (2014); Arden Rowell, *Foreign Impacts and Climate Change*, 39 HARV. ENVTL. L. REV. 371, 400–18 (2015); William D. Nordhaus, *Estimates of the Social Cost of Carbon: Background and Results from the RICE-2011 Model, National Bureau of Economic Research Working Paper 17540* at 8–10 (2011); RUTH BELL & DIANNE CALLAN, ENVTL. LAW INST. & WORLD RES. INST., MORE THAN MEETS THE EYE: THE SOCIAL COST OF CARBON IN U.S. CLIMATE POLICY, IN PLAIN ENGLISH 1 (2011); Michael Greenstone et al., *Developing a Social Cost of Carbon for US Regulatory Analysis: A Methodology and Interpretation*, 7 REV OF ENVTL. ECON. & POL. 23, 24 (2013); Anthony Heyes et al., *The Use of a Social Cost of Carbon in Canadian Cost-Benefit Analysis*, 39 CAN. PUB.

Despite the prominence of CBA and SCC in U.S. and Canadian decision-making, virtually no scholarly attention assesses the similarities and differences between practices in each country. This Article is the first to examine and compare use of the SCC in Canadian and U.S. carbon emission regulatory decision-making. It reveals that despite fundamental differences between the two countries, regulators on either side of the border use similar or identical dollar values and modeling. These similarities assume, however, commonalities across the two countries that lack an empirical basis, including with respect to risk tolerance, moral stances, value of ecosystem services, and the value of a human life. Further, the analysis finds that differences in the way SCC values are used by Canadian and U.S. decision-makers are not rooted in a tenable rationale, demonstrating another instance of cost-benefit analysis being susceptible to bias and arbitrary decisions. Ultimately, this undermines the credibility of regulatory decisions in the carbon emissions realm at a time when integrity is critical.

Part I of this Article presents the concepts of SCC and CBA, including rationale and critiques of each. It goes on to explain the basis and institutional context around use of these analytical tools in both Canada and the United States. Particular attention is given to how SCC values are estimated. Part II examines technical guidance in both countries, mapping evolution of SCC methods and values, and identifying important changes in recent years. Part III takes an in-depth look at the use of SCC in regulatory impact analyses for emissions from coal-fired power plants and emissions from light-duty vehicles in each country, examining what SCC values were used by Canadian and U.S. regulators and how those values were employed in the broader CBA context. Part IV discusses similarities, differences, implications, and recommendations for improvement. Ultimately, the Article concludes by acknowledging that the Canada-U.S. SCC story confirms common criticisms about SCC and CBA, but that SCC also presents an opportunity for further evolution and improvement in CBA. As such, this Article is of broad relevance to those interested in how CBA and SCC are applied—and how improvements might be made—in regulatory decision-making in North America and around the world.[11]

POL'Y S67, S69–70 (2013). *Contra* Robert W. Hahn & Robert A. Ritz, *Does the Social Cost of Carbon Matter? Evidence from US Policy*, 44 J. LEGAL STUD. 229, 241–46 (2015).

11. Indeed, use of CBA has been expanding globally. *See* Michael A. Livermore et al., *Global Cost-Benefit Analysis*, *in* THE GLOBALIZATION OF COST-BENEFIT ANALYSIS IN ENVIRONMENTAL POLICY 3 (Michael A. Livermore & Richard Revesz eds., 2013).

I. SOCIAL COST OF CARBON & COST BENEFIT ANALYSIS

A. OVERVIEW OF SOCIAL COST OF CARBON & COST-BENEFIT ANALYSIS

SCC refers to an estimated dollar value representing net effects associated with an incremental increase in carbon emissions in a given year.[12] It is typically expressed in dollars per ton of carbon dioxide. As such, SCC dollar values are sometimes also characterized as representing the "marginal damage of an additional ton of carbon dioxide emitted."[13] In economic terms, climate change is the market failure that results when the externality of carbon pollution costs are not priced into transactions, and SCC is a quantification of such externalities for the purpose of internalizing these costs into the economy through regulatory action. SCC has evolved to become a central part of CBA for proposed regulatory action directed at carbon dioxide emissions. In both Canada and the U.S., it has become the primary tool used to quantify and then assess environmental costs and benefits. Each country has developed its own institutional approach, as described below in sub-sections I.B and I.C.

Generating SCC estimates for a particular year is a relatively complex affair. Pizer et al. lay out four relatively distinct steps: (i) projecting a future path of global greenhouse gas emissions; (ii) translating this emissions path into alternate scenarios of climate change; (iii) estimating the physical impact of the resulting climate change on humans and ecosystems; and (iv) monetizing these impacts and discounting future monetary damages back to the year in question.[14] In simple terms, this could be understood as scientists gathering data and scenarios, economists working to put that information into meaningful form, and then lawmakers integrating such information through the tool of CBA[15]—notwithstanding critiques discussed elsewhere in this Article.[16]

Estimates for the SCC are generated using Integrated Assessment Models ("IAMs") developed by the academic community. These IAMs integrate different sets of data, including GHG emissions forecasting, climate change science, and projected climate change impacts (for example on human health, agricultural productivity, and property damage) to generate a dollar value of the cost of

12. Pizer, *supra* note 10; *see also* U.S. GOV'T INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE TO THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 at 2 (2015) [hereinafter U.S. WG TECHNICAL DOCUMENT]; *see also* ECCC TECHNICAL DOCUMENT, *supra* note 7, at i.

13. *See, e.g.*, ECCC TECHNICAL DOCUMENT, *supra* note 7, at 1; *see also*, SUSTAINABLE PROSPERITY, THE VALUE OF CARBON IN DECISION-MAKING: THE SOCIAL COST OF CARBON AND THE MARGINAL ABATEMENT COST 2 (2011). *See also* Rowell, *supra* note 10, at 372.

14. Pizer, *supra* note 10, at 1189.

15. This makes SCC an interesting interdisciplinary space where science, economics, and law converge.

16. But to foreshadow for a moment, Bell & Callan suggest that, "Economists do not second-guess the scientists. But they do pick and choose among the latter's many estimates, making judgments about which to include in the economic modeling of damages, and funneling the climate science through their own methods of modeling the world." Bell & Callan, *supra* note 10, at 2.

damage caused by climate change resulting from carbon pollution.[17] An interdepartmental expert working group in the U.S. (described in more detail below), whose work underpins SCC estimates in both Canada and the U.S., uses three different IAMs for estimating SCC: the PAGE model,[18] the FUND model,[19] and the DICE model.[20] In its review of the working group's SCC work, a recent technical report from Canada's Ministry of Environment and Climate Change succinctly summarizes how these models are used to generate SCC values:

> For each year, the U.S. SCC estimates are derived by running each of the selected three IAMs 10,000 times with random draws from the equilibrium climate sensitivity (ECS) probability distribution (and other model-specific uncertain parameters), for each of five sets of Gross Domestic Product (GDP), population and emissions trajectories over a period extending from the present day to 2300, for each of three discount rates. The outputs yield a frequency distribution of SCC estimates (\$/tonne CO_2) conditional on each discount rate for a given year. The models are run for each year over the time horizon considered to be relevant for policy and/or regulatory analysis . . . .
>
> To produce a range of plausible estimates to use in regulatory analysis, the SCC estimates were averaged across models and scenarios (each having equal weight), implicitly defining a frequency distribution of the SCC conditional on each discount rate in a given year. This approach helps to capture some of the key uncertainties associated with forecasting socio-economic and emissions scenarios, the climate system response to increased GHG concentrations, and balances out the strengths and weaknesses of the different IAMs.[21]

Through this modeling practice, experts produce specific numeric SCC values. For example, the central values[22] for SCC issued by the U.S. Working Group in

17. *See, e.g.*, ECCC TECHNICAL DOCUMENT, *supra* note 7, at 1.

18. As described in the ECCC Technical Document, the PAGE model was "developed by Chris Hope (University of Cambridge), features exogenous GDP growth, along with damages being split into the economic, non-economic and catastrophic categories, all of which are calculated separately for eight different regions. The model considers catastrophic damage in a separate damage function, attributing a stronger probability with increased temperature levels." *Id.* at 5.

19. As described in the ECCC Technical Document, the FUND model was "developed by David Anthoff (University of California, Berkeley) and Richard Tol (University of Sussex), also features exogenous GDP growth as well as separately calibrated damage functions for 8 market and non-market sectors, which have different functional forms to calculate damage over 16 regions. The model does not account for the possibility of catastrophic events. Adaptation is included both implicitly and explicitly in the model, depending on the sector." *Id.*

20. As described in ECCC Technical Document, the DICE model was "developed by William Nordhaus (Yale), is an optimal growth production model that is based on a global production function with atmospheric CO_2 concentrations incorporated as an extra variable. This model perceives GHG emissions reductions as an investment in natural capital, implying that investing today (lower consumption) will enable higher future consumption. Technological progress is represented in the model by a declining carbon intensity of production over time. Adaptation is not included explicitly in the model, although it is implicitly included through the damage function. DICE differs from other models in that (1) GDP is endogenous, and (2) damages in a given period will reduce investment at that time, increasing damages in the future." *Id.*

21. *Id.* at 3–5. For a detailed account, see U.S. WG TECHNICAL DOCUMENT, *supra* note 12.

22. "Central Value" is the value generated by the models using the 3% discount rate. More specifically, the

2010 and 2013 were $21 and $28 per ton (USD), respectively. Such figures are discussed in detail in Part II.

In practical application, SCC is an input—quantitative fodder—for the broader CBA employed in regulatory decision-making in Canada and the United States. In the context of climate change and regulation of carbon dioxide emissions, it is the CBA that is a central part of regulatory decision-making. It is the overarching analytical tool used to assess the benefits and costs of a particular course of action.[23] The CBA compares costs that would result from regulatory action to reduce carbon dioxide emissions with the benefits that society would incur, including those associated with avoided damage to the environment and public health.[24] As described in more detail below, both Canada and the United States employ CBA when analyzing potential regulatory action and have done so for several years now.[25]

B. UNITED STATES: USE OF COST-BENEFIT ANALYSIS AND SOCIAL COST OF CARBON

Cost-benefit analysis has been part of regulatory development in the United States pursuant to a series of Executive Orders.[26] Requirements today flow chiefly from Executive Order 12866, which requires U.S. government agencies to conduct a cost-benefit analysis for all proposed regulations.[27] CBA is part of the "Regulatory Impact Analysis" ("RIA") that the responsible agency generates for regulatory proposals. The basis for CBA is also shaped by Executive Order 13563, which reaffirmed and supplemented Executive Order 12866 in 2011 by directing federal agencies to conduct regulatory actions based on the best available science and to use the best available techniques to quantify benefits and costs accurately.[28]

The U.S. Office of Management and Budget's ("OMB") Circular A-4, issued in 2003, provides additional guidance to assist agencies in "defining good regulatory analysis . . . and standardizing the way benefits and costs of Federal regulatory actions are measured and reported."[29] The Circular provides guidance for systematic evaluation of qualitative and quantitative benefits and costs,

central value is the average SCC across all three models at the 3% discount rate. This is discussed in more detail in Part II of this Article, as is the fact that the U.S. working group actually generates four different SCC values using three different discount rates.

23. IMAD A. MOOSA & VIKASH RAMIAH, THE COSTS AND BENEFITS OF ENVIRONMENTAL REGULATION 85 (2014). Many articulations of CBA exist, though the concept is relatively consistent. For a succinct overview, see JAMES SALZMAN & BARTON H. THOMPSON, JR., ENVIRONMENTAL LAW AND POLICY, 34–38 (3d ed. 2010).

24. David M. Driesen, *Cost-Benefit Analysis and the Precautionary Principle: Can They be Reconciled?*, 2013 MICH. ST. L. REV 771, 776

25. *Infra* parts I.B & C.

26. Exec. Order No. 12,866, 58 Fed. Reg. 51,735 (Oct. 4, 1993); Exec. Order No. 13,258, 67 Fed. Reg. 9385 (Feb. 26, 2002); Exec. Order No. 13,422, 72 Fed. Reg. 2763 (Jan. 18, 2007).

27. Exec. Order No. 12,866, 58 Fed. Reg. 51,735 (Oct. 4, 1993).

28. Exec. Order No. 13,563, 76 Fed. Reg. 3821 (Jan. 18, 2011).

29. OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, CIRCULAR A-4: REGULATORY ANALYSIS 1 (2003).

including monetization and selection of discount rates, as well description of assumptions and uncertainty. According to Circular A-4, if costs or benefits cannot be quantified, agencies should discuss them qualitatively.[30]

U.S. federal agencies began including estimates of the social cost of carbon as early as 2008, following a decision by the U.S. Court of Appeals for the Ninth Circuit.[31] In the case of *Center for Biological Diversity v. National Highway Traffic Safety Administration*,[32] a final rule on fuel economy standards issued by the National Highway Traffic Safety Administration ("NHTSA") was challenged in court. The final rule had stated that monetary value of the benefit of reduced carbon pollution could not be determined because of wide variation in estimates of the SCC at the time. The petitioners argued otherwise, asserting that the NHTSA had acted arbitrarily and capriciously by failing to incorporate a monetized value for carbon emissions in its decision-making. The court agreed, directing the NHTSA to include a monetized value of carbon in an updated regulatory impact analysis for the regulation, stating that, "while the record shows that there is a range of values, the value of carbon emissions reduction is certainly not zero."[33]

As part of the government's response, the OMB, Office of Information and Regulatory Affairs, and the Council of Economic Advisors convened an Interagency Working Group on the SCC in 2009. This group developed interim SCC estimates in 2009 and then released an official Technical Support Document in March 2010.[34] During this period, agencies began incorporating SCC into Regulatory Impact Analyses ("RIAs") for proposed regulatory actions.[35] At the same time, the U.S. Working Group recommended that SCC estimates be revisited on a regular basis or as updates that reflect the growing body of scientific and economic knowledge become available.[36] Following up on this recommendation, the U.S. working group issued an updated Technical Support Document in June 2013.[37] They did so again in 2015 (see the timeline in Table 1 below), and this group continues its work today, although implications flowing

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30. *Id.* at 10. *See also* GOV'T ACCOUNTABILITY OFFICE, FEDERAL RULE MAKING: AGENCIES INCLUDED KEY ELEMENTS OF COST-BENEFIT ANALYSIS, BUT EXPLANATIONS OF REGULATIONS' SIGNIFICANCE COULD BE MORE TRANSPARENT 23 (2014).

31. *See generally* Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172 (9th Cir. 2008). The court ruled that the NHTSA had acted arbitrarily and capriciously by not generating and using a monetized value in the regulatory impact analysis for a final rule on fuel economy standards issued in 2006.

32. *Id.*

33. *Id.* at 1200.

34. U.S. GOV'T INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE TO THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 (2010).

35. Rowell, *supra* note 10, at 381.

36. U.S. GOV'T INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 34, at 1, 3, 4, 29, 33.

37. U.S. GOV'T INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE TO THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 (2013).

from the November 2016 U.S. election are cause for some uncertainty.[38] The most recent update noted that "[n]ew versions of the three integrated assessment models used by the U.S. government to estimate the SCC (DICE, FUND, and PAGE), are now available and have been published in the peer reviewed literature."[39]

Concurrent with the work of the U.S. federal government, the National Academies of Sciences, Engineering and Medicine, on request by the U.S. Working Group, convened a committee of experts to research the modeling of economic aspects of climate change to further inform future revision to SCC estimates.[40] This committee released an interim report in 2016, with a final report released in January 2017.[41] The report's recommendations are far-reaching, setting out near-term and long-term recommendations that aim to provide guidance to improve the scientific basis, characterization of uncertainty, and transparency of the SCC estimation framework.[42] Additionally, the Government Accountability Office ("GAO") conducted a performance audit from November 2013 to July 2014 that reviewed the U.S. Working Group's process for development of SCC estimates.[43] How these independent reviews factor into future SCC updates is referenced in relevant discussions below.

C. CANADA: USE OF COST-BENEFIT ANALYSIS AND SOCIAL COST OF CARBON

The Government of Canada requires all departments and agencies to conduct a CBA of proposed regulatory action.[44] This CBA constitutes a significant part of the Regulatory Impact Analysis Statement ("RIAS") that a sponsoring department or agency must generate for any regulatory proposal.[45] In cases where a regulatory proposal deals with GHG emissions, SCC is used to express the monetary value of changes in emission amounts.[46] The Ministry of Environment

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38. For preliminary perspectives, see Matthew Philips, Mark Drajem & Jennifer A. Dlouhy, *How Climate Rules Might Fade Away*, BLOOMBERG NEWS (Dec. 15, 2016), https://www.bloomberg.com/news/articles/2016-12-15/how-climate-rules-might-fade-away.

39. U.S. WG TECHNICAL DOCUMENT, *supra* note 12, at 4.

40. NAT'L ACADS. OF SCIS., ENG'G & MED., *Assessing Approaches to Updating the Social Cost of Carbon*, http://sites.nationalacademies.org/DBASSE/BECS/CurrentProjects/DBASSE_167526 (last visited May 15, 2017) (Interim Report).

41. NAT'L ACADS. OF SCIS., ENG'G & MED., ASSESSMENT OF APPROACHES TO UPDATING THE SOCIAL COST OF CARBON: PHASE 1 REPORT ON A NEAR-TERM UPDATE (2016) (Interim Report). NAT'L ACADS. OF SCIS., ENG'G & MED., VALUING CLIMATE DAMAGES: UPDATING ESTIMATION OF THE SOCIAL COST OF CARBON DIOXIDE (2017) (Final Report).

42. NAT'L ACADS. OF SCIS., ENG'G & MED., VALUING CLIMATE DAMAGES: UPDATING ESTIMATION OF THE SOCIAL COST OF CARBON DIOXIDE 3 (2017) (Final Report summarizing recommendations).

43. GOV'T ACCOUNTABILITY OFFICE, *supra* note 30.

44. GOV'T OF CAN., CABINET DIRECTIVE ON REGULATORY MANAGEMENT at 6(G) (2010), https://www.canada.ca/en/treasury-board-secretariat/services/federal-regulatory-management/guidelines-tools/cabinet-directive-regulatory-management.html.

45. *Id.* Further guidance is provided by Canada's Treasury Board Secretariat. TREASURY BD. OF CAN. SECRETARIAT, CANADIAN COST-BENEFIT ANALYSIS GUIDE: REGULATORY PROPOSALS (2007).

46. ECCC TECHNICAL DOCUMENT, *supra* note 7.

and Climate Change (referred to as "Environment and Climate Change Canada," and previously "Environment Canada") is typically the sponsoring department of GHG regulations in Canada and is the lead department on work related to SCC.[47]

Environment and Climate Change Canada ("ECCC") began integrating the SCC into decision-making in 2010.[48] Unlike in the U.S., this incorporation was not prompted by litigation. Rather, noting the research and analysis undertaken by the U.S. Working Group, ECCC struck an interdepartmental Canadian Working Group to review approaches to the valuation of GHG emissions in decision-making.[49] The Canadian Working Group first considered two main options: the U.K.'s approach that uses a "shadow price" linked to a national emissions reduction target;[50] or the U.S. approach linking the SCC to specific regulatory actions.[51] Ultimately, the U.S. approach emerged as the Canadian Working Group's choice, according to the government, "because it was well suited to Environment and Climate Change Canada's regulatory context, the Government of Canada's approach to cost-benefit analysis, and aligned with the interdepartmental working group's objective to use credible, robust values."[52]

In 2011, the Canadian Working Group recommended the adoption of SCC values developed by the U.S. Working Group, as opposed to conducting such modeling and analysis on its own.[53] Since that time, SCC has been incorporated as part of CBA in RIAS for regulatory proposals dealing with carbon emissions such as emission reductions for automobiles and coal-fired power plants. Details of two of such regulations and SCC analyses are summarized and discussed in detail in Part II below.

Similar to the U.S. Working Group, the Canadian Working Group also concluded that it would be necessary to continually review SCC estimates in order to incorporate advances in sciences, economic literature, and modeling.[54] However, Canada's approach to calculating and using SCC remained unchanged until 2015. When ECCC did reconvene the Canadian Working Group, the work once again heavily relied on and built upon the U.S. approach. In particular, the recent Canadian work is based on updates and technical corrections completed by the United States in November 2013 and July 2015.[55] Canada's work culminated in the release of the *Technical Update to Environment and Climate Change*

47. It was ECCC, for example, that published Canada's most recent SCC technical update. *See id.*
48. For this point and a full summary, see *id.*
49. *Id.*
50. *See* U.K. GOV'T DEP'T OF ENERGY & CLIMATE CHANGE, CARBON VALUATION IN UK POLICY (2009). *See also* U.K. GOV'T DEP'T OF ENERGY & CLIMATE CHANGE, UPDATED SHORT-TERM TRADED CARBON VALUES USED FOR UK PUBLIC POLICY APPRAISAL (2015); *see also* ECCC TECHNICAL DOCUMENT, *supra* note 7, at 12.
51. U.S. WG TECHNICAL DOCUMENT, *supra* note 12, at 2; *see also* ECCC TECHNICAL DOCUMENT, *supra* note 7, at 12–13.
52. ECCC TECHNICAL DOCUMENT, *supra* note 7, at i.
53. *Id.*
54. *Id.* at 14.
55. ECCC TECHNICAL DOCUMENT, *supra* note 7, at 23–25.

Canada's Social Cost of Greenhouse Gas Estimates in March 2016. Differences between Canadian and U.S. values and approaches are discussed in detail in Part II. Table 1 presents a side-by-side summary of the evolution of the SCC regimes in both countries.

TABLE 1
TIMELINE OF DEVELOPMENT AND UPDATES TO SCC IN THE U.S. AND CANADA

U.S.	Year	Canada
Decision of U.S. Court of Appeals for the Ninth Circuit stating carbon emission values should be monetized and considered in regulatory decisions	2008	
U.S. agencies start incorporating individually developed estimates of SCC into regulatory analyses	2008	
OMB and Council of Economic Advisers convene interagency working group on SCC; group releases interim estimates	2009	
U.S. Working Group releases its Technical Support Document	2010	ECCC convenes an interdepartmental working group to review approaches to valuing GHG emissions
	2011	Canadian Working Group recommends adoption of U.S. SCC values
U.S. Working Group releases an update to the Technical Support Document, revising SCC estimates	2013	
U.S. Working Group releases another update to the Technical Support Document	2015	ECCC reconvened the Canadian Working Group; recommended updating SCC values based on U.S. improvements
U.S. National Academies of Sciences began research project to inform future revision to the SCC (interim report released in 2016; final report due in 2017)	2016	ECCC releases a Technical Update to Canada's SCC based on the 2015 U.S. update

D. SOCIAL COST OF CARBON & COST-BENEFIT ANALYSIS: LIMITATIONS AND CRITIQUES

Notwithstanding the significant body of work and experience in Canada and the United States, SCC attracts strong criticisms due to limitations inherent in the calculation. The 2016 technical update from the Canadian Working Group comprehensively summarizes these limitations: uncertainty in parameters used for modeling, insufficient transparency in modeling practices and input judgments, inadequate representation of non-catastrophic climate damages in the modeling (for example, not all sectors of the economy are included, nor is regional variability), inadequate capture of catastrophic climate damages in the modeling, unevenly captured or unrepresented inter-sector and inter-regional interactions in the modeling, assumed substitutability of environmental amenities (such as an inappropriate assumption that natural system losses can be compensated through non-climate goods), inadequate consideration in the modeling of variance in individuals' risk aversion to high-impact climate outcomes, inadequate factoring of equity concerns in the modeling (which would give more weight to impacts on low-income regions), high impact of choice of discount rate as a key input to the modeling (as discussed below, this greatly affects the final SCC value generated by modeling and reflects judgments about what value to place on future generations), uncertainties regarding adaptation response and how to factor it into the modeling (i.e. expected impacts and technological responses), and expression of SCC as global value (as opposed to using just domestic values, which has been standard practice in cost-benefit analysis).[56]

There is a prevailing view emerging that assigning no value at all to future harms is inappropriate given the certainty of some measures of climate damage.[57] Yet, there is a range of views regarding SCC, from commentators who suggest that uncertainties inherent in SCC estimates render it useless,[58] to those who nevertheless believe that these estimates are useful for policy-making.[59] Substantial reliance on SCC by regulators without resolution of its clear limitations has generated significant criticism.[60] Critiques and calls for improvement are preva-

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56. *Id.* at 16–19. For another succinct summary of limitations, see Richard Revesz, *Improve Economic Models of Climate Change*, 508 NATURE 173, 174 (2014).

57. Indeed, this is basically the rationale of the court in the decision that precipitated use of SCC in regulatory decision-making. *See* Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172 (9th Cir. 2008); *see also* Kyle McKay, Can We Actually Calculate the Social Cost of Carbon? 2 (2013) (Univ. of Md. School of Public Policy) (working paper), https://works.bepress.com/kylemckay/3/download/.

58. *See* Revesz, *supra* note 56, at 174 (pointing out that some academics say that uncertainties render the estimate useless).

59. *Id.* Obviously, Canadian and U.S. governments align with this latter view.

60. *See, e.g.*, Bell & Callan, *supra* note 10; *see also* Rowell, *supra* note 10; Hahn & Ritz, *supra* note 10; Alan Krupnik et al., *Putting a Carbon Charge on Federal Coal: Legal and Economic Issues* (Resources for the Future, Discussion Paper No. RFF-DP-15-13, Mar. 2015), http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-15-13.pdf; Kyle McKay, Can We Actually Calculate the Social Cost of Carbon? 2 (2013) (Univ. of Md. School of Public Policy) (working paper), https://works.bepress.com/kylemckay/3/download/.

lent in a growing body of literature that largely traces the themes identified in the ECCC technical document.[61] Bell and Callan succinctly capture the thrust of critiques:

> In short, economists who model the SCC must grapple with hugely complex systems and exceptional levels of uncertainty, translating many natural variables into monetary values that represent the benefits of acting to control the growth of greenhouse gas emissions. This situation confronts them with a moving target, as climate scientists are continually learning more about how the natural world is responding to the constantly changing array of human influence. The effort through IAMs to impose order on a rapidly evolving set of observations, facts, and data should not obscure the significance of the uncertainties and assumptions inherent in these calculations, and the monetization in these models should be understood within this context as a wide-ranging estimate of costs.[62]

As with any modeling, inputs matter greatly. Generating SCC estimates requires modelers to make critical choices that ultimately dictate the quality and reliability of the outputs. A threshold choice is which model to use (there are more in the world than the three listed above, though they are the most commonly used). Modelers must then make assumptions regarding inputs such as baseline emissions scenarios, rates of economic growth, and how much weight to give climate change impacts inside and outside the jurisdiction considering the SCC.[63] As Heyes et al. have explained, the IAMs used in SCC modeling are "highly stylized and highly parameterized,"[64] meaning there is a significant amount of uncertainty hidden behind SCC estimates.[65] This uncertainty has resulted in a very large range of SCC estimates coming out of the modeling.

There is one input assumption that has a particularly dramatic effect in the SCC context: discount rate. A discount rate is the value given to money over time. It represents the tradeoff between what a dollar is worth today and what a dollar would be worth in the future.[66] Goulder and Williams effectively articulate this in relation to climate change:

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61. *See* ECCC TECHNICAL DOCUMENT, *supra* note 7, at 16–19.

62. Bell and Callan, *supra* note 10, at 8–9.

63. Pizer et al., *supra* note 10; *see also*, Lawrence H. Goulder & Roberton C. Williams, III, *The Choice of Discount Rate for Climate Change Policy Evaluation* (Resources for the Future, Discussion Paper No. RFF DP 12-43, 2012), http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-12-43.pdf.

64. Heyes et al., *supra* note 10, at S70.

65. *Id.* One might argue this is a more polite restatement of the well-known George Box quote at the start of this article: "All Models are wrong, but some are useful." BOX & DRAPER, *supra* note 1.

66. For a full description and discussion, see Cass R. Sunstein & Arden Rowell, *On Discounting Regulatory Benefits: Risk, Money, and Intergenerational Equity*, (John M. Olin Program in Law & Econ. Working Paper No. 252, 2005), http://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=1339&context=law_and_economics.

> Most of the climate-related benefits from current policy efforts would take the form of avoided damages many years from now, whereas many of the costs would be borne in the nearer term. A high consumption discount rate thus tends to shrink the present value of benefits relative to the present value of costs and weakens the case for aggressive current action.[67]

Choosing a discount rate for the assessment of climate change policy has important implications because a relatively a small difference in the choice of this rate can make a very large difference in the policy assessment.[68] In short, SCC estimates decrease as discount rates increase—a higher discount rate assumes increasing wealth in future generations and, as a corollary, suggests that today's less-wealthy population should therefore not pay today.[69] It is important not to collapse the present analysis here into a view that this is limited to the discount rate; but it is safe to say the discount rate is the most significant input to SCC modeling.[70]

Given the consequences, discount rate has been the subject of heated debate. The most well-documented and illustrative divergence of views took place several years ago between Sir Nicholas Stern, an esteemed economist from Britain, and Ted Nordhaus, a leading economics scholar at Yale University.[71] The often-quoted Stern Review[72] estimated SCC to be more than \$85/ton CO_2. At approximately the same time, and partly in response to that work, Nordhaus generated an estimate of approximately one-tenth that value.[73] The Nordhaus-Stern divergence illustrates the significant effect different discount rates have. Stern used a value of approximately 1.4% while Nordhaus used approximately 3%.[74]

The debate continues. A 2015 study by researchers at Stanford University asserted that the U.S. Working Group SCC estimate of \$37/ton CO_2 was grossly

67. Goulder & Williams, *supra* note 63, at 1.

68. *Id.*

69. This is a highly controversial and fundamental part of the SCC debate that will be taken up in more detail in Part II. In short, the controversy is around the assumption that there is a continually growing economy. Nordhaus assumes there is, whereas others suggest that climate change will have a negative impact on the economy so projections should attract lower growth forecasts. That is essentially the view of Stanford researchers Moore & Diaz. Frances C. Moore & Delavane B. Diaz, *Temperature Impacts on Economic Growth Warrant Stringent Mitigation Policy*, 5 NATURE CLIMATE CHANGE 127 (2015). Put another way by Bell and Callan, "as climate change science becomes increasingly concerning, it becomes a weaker bet that future generations will be better off." Bell & Callan, *supra* note 10, at 9.

70. "Literature shows that the SC-CO_2 is quite sensitive to assumptions about the discount rate." EPA, REGULATORY IMPACT ANALYSIS OF THE CROSS-STATE AIR POLLUTION RULE (CSAPR) UPDATE FOR THE 2008 NATIONAL AMBIENT AIR QUALITY STANDARDS FOR GROUND-LEVEL OZONE 5–35 (2016).

71. *See* William D. Nordhaus, *A Review of the* Stern Review on the Economics of Climate Change, 45 J. ECON. LITERATURE 686 (2007); *see also* Goulder & Williams, *supra* note 63, at 1–2.

72. NICHOLAS STERN, STERN REVIEW ON THE ECONOMICS OF CLIMATE CHANGE (2007).

73. Nordhaus, *supra* note 71, at 698; *see also* Heyes et al., *supra* note 10, at S71.

74. *See* Bell & Callan, *supra* note 10, at 9.

undervalued at the time, and should have been \$220/ton CO_2.[75] Months later, ECCC published its most recent technical update essentially re-endorsing the U.S. Working Group's latest round of SCC estimates.[76] Analysis in this Article will show just how Canada and the United States use discount rate in regulatory decision-making and what significant impacts this has.

Stepping back to the broader context of Canadian and U.S. regulatory decision making, there are strong ties between SCC critiques and those of CBA more broadly, including with respect to discount rate. Similar to SCC, on a normative level CBA seeks to maximize the net benefits of regulation.[77] Similarly, on an analytical level, the objective of CBA is to determine the change in net benefits brought about by a new or amended policy.[78] This determination typically takes the form of quantifying different dimensions of a decision, equating monetary values, and comparing the results. In many ways, SCC is like a microcosm of CBA.

Simple as the CBA process sounds and elegant as it may appear, difficulties inherent in measuring costs and benefits make the process extremely challenging in practice. Unsurprisingly, similar to SCC, CBA has also attracted much attention and criticism. Such criticisms of CBA are numerous and have been widely discussed;[79] but they can be distilled into the following several areas of concern:

- Unjustified quantification or commodification of goods seen to have special status such as human life or wilderness areas[80]—some argue the practice to be immoral or unethical;[81]
- Inherent uncertainty due to challenges in quantification of inputs to the analysis and realities of imperfect information;[82]
- Unfair distribution of benefits favoring interests of the wealthy over the poor and of the present generation over the future (i.e. intra and inter-generational equity);[83]

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75. Ker Than, *Estimated Social Cost of Climate Change Not Accurate, Stanford Scientists Say*, STANFORD NEWS (Jan. 12, 2015), http://news.stanford.edu/2015/01/12/emissions-social-costs-011215/; *see also*, Moore & Diaz, *supra* note 69. Note that the different SCC values were arrived at by modelers assuming substantially slower economic growth rates due to climate impacts.

76. ECCC TECHNICAL DOCUMENT, *supra* note 7.

77. RICHARD L. REVESZ & MICHAEL A. LIVERMORE, RETAKING RATIONALITY 10 (2008).

78. GOV'T OF CAN., *supra* note 44, at 6(G).

79. *See* SALZMAN & THOMPSON, *supra* note 23, at 34–38; *see also* MOOSA & RAMIAH, *supra* note 23, at 85; Sidney A. Shapiro & Christopher H. Schroeder, *Beyond Cost-Benefit Analysis: A Pragmatic Reorientation*, 32 HARV. ENVTL. L. REV. 433 (2009).

80. Shapiro & Schroeder, *supra* note 79, at 456–57; *see also* REVESZ & LIVERMORE, *supra* note 77, at 13.

81. *See* MATTHEW ADLER & ERIC POSNER, NEW FOUNDATIONS OF COST-BENEFIT ANALYSIS 25–61 (2006); *see also* Jonathan S. Masur & Eric A. Posner, *Climate Regulation and the Limits of Cost-Benefit Analysis*, 99 CAL. L. REV. 1557, 1597–98 (2011).

82. REVESZ & LIVERMORE, *supra* note 77, at 14; Frank Ackerman & Lisa Heinzerling, *Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection*, 150 U. PA. L. REV. 1553, 1578–81 (2001); *see also* ADLER & POSNER, *supra* note 81, at 25–61.

83. REVESZ & LIVERMORE, *supra* note 77, at 14.

- Potential for bias and manipulation, both by experts conducting the analysis and decision-makers using CBA outputs.[84]

Similar to SCC, there is wide recognition that CBA is an imperfect tool, even among its proponents.[85] On the question of how to address these imperfections, however, opinions vary widely and deeply. Some argue the methodology is rotten to the core and should be completely set aside in favor of other analytical approaches.[86] Others remain committed to it in principle and to improving it in practice.[87] Rather than engaging in lengthy debate here, it suffices for present analytical purposes to note that these are long-standing, fundamental, ongoing arguments. Most important to this Article is the view that close examination of SCC in practice represents an opportunity to make observations that may be used for further improvement of both SCC and CBA. The premise here is a pragmatic one: as long as Canada and the United States are both using SCC, improvement ought to be pursued. Part II presents analysis in that direction.

II. SAME-SAME BUT TECHNICALLY DIFFERENT: CANADA & U.S. SOCIAL COST OF CARBON TECHNICAL GUIDANCE

To set the stage for examining specific regulatory analyses in Part III, this Part begins with a discussion of Canadian and U.S. technical analysis and the observable differences in these approaches. Throughout this discussion, links to SCC limitations and critiques are discernable, particularly with respect to discount rates. These links are given more direct attention in the final part of this Article.

Development of technical guidance has largely been a case of follow-the-leader, with the U.S. Working Group leading and the Canadian Working Group following.[88] Recently released technical support documents are a case in point. The United States released its latest revision in July 2015,[89] and Canada followed suit in March 2016.[90] The relationship is more than temporal. A close review of these documents reveals significant substantive similarities, primarily as a product of Canada adopting much of the work of the U.S. Working Group. Overall, it is fair to say that Canada's SCC technical work is almost entirely based on that of the U.S. Working Group.

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84. Shapiro & Schroeder, *supra* note 79, at 502; *see also* Ackerman & Heinzerling, *supra* note 82, at 1578–81.

85. *See* Masur & Posner, *supra* note 81, 1580–81; *see also* REVESZ & LIVERMORE, *supra* note 77.

86. *See* Ackerman & Heinzerling, *supra* note 82, at 1578–81; *see also* Shapiro & Schroeder, *supra* note 79 at 456–57.

87. *See* Masur & Posner, *supra* note 81, at 1596–98; *see also* REVESZ & LIVERMORE, *supra* note 77, at 15–16.

88. See Table 1, *supra* Part I.

89. U.S. WG TECHNICAL DOCUMENT, *supra* note 12.

90. ECCC TECHNICAL DOCUMENT, *supra* note 7.

For example, starting in 2011 and repeating again in 2015, the Canadian Working Group decided to simply adopt results of the U.S. Working Group on SCC. As explained in the 2015 Technical Update: "[w]hile alternative parameters, such as declining discount rates, were discussed, it was ultimately determined that it was more practical to adopt the U.S. results. Revisiting core parameters would have required significant investment by the Government of Canada to acquire and run the IAMs used in the analysis."[91] The Canadian Technical Document goes on to rationalize this decision by suggesting that the integrated nature of the Canadian and American economies means that alignment of regulatory and analytical approaches can be mutually beneficial.[92]

Interestingly, there is no clear discussion in the Canadian technical guidance or elsewhere about why the *differences* between Canadian and American economic or non-economic values and preferences were not closely considered or factored in. For example, no attention is given to whether Canadian's views on moral judgments, equity concerns, or risk aversion might be materially different than those of Americans. Instead, the Canadian document briefly states that "[a]lthough both countries will feel the impacts of climate change differently, the costs included in the Social Cost of Carbon are global in nature. As such, estimates of climate change impacts for regulatory policies should be very similar."[93] Full consideration of this point is beyond the scope of this Article (though a fertile area for further study in the Canada-U.S. context).[94] For present purposes, Canada's position illustrates a willingness to simply adopt the determinations of the U.S. Working Group without deep scrutiny or a transparent discussion about underlying rationale and analysis—if any.

Canada does diverge from U.S. values to some degree, however. The Canadian Working Group decided to make what the government characterized as "three minor adjustments" deviating from the U.S. approach.[95] First, the Canadian Working Group uses only one discount rate (3%), compared to the United States, which uses three different discount rates (2.5%, 3%, 7%).[96] In adopting a single rate, the Canadian Working Group offered minimal rationale despite the discount rate having the highest impact and being the most significant judgment-laced input to SCC estimates.[97] The Group merely stated that using only the 3% rate was in line with applicable federal guidance[98] and that "[t]here was also

91. *Id.* at 13.

92. *Id.*

93. *Id.*

94. *See* Rowell, *supra* note 10 (discussing significant concerns around using a global as opposed to domestic SCC value).

95. ECCC TECHNICAL DOCUMENT, *supra* note 7, at 13.

96. *Id.*

97. *See* David Weisbach & Cass Sunstein, *Climate Change and Discounting The Future: A Guide for the Perplexed,* 27 YALE L. & POL'Y REV. 433, 441 (2009); *see also* Rowell, *supra* note 10, at 382–86.

98. GOV'T OF CANADA, *supra* note 44.

preference among Canadian Group members to limit the number of SCC values considered, as it was felt that it would be challenging to present four sets of cost-benefit results to decision-makers."[99] As will be discussed further below, presenting four sets of cost-benefit results based on three different discount rates is precisely what the U.S. decision-makers use in common practice.[100]

The second adjustment made by the Canadian working group relates to the a 95th percentile estimate, the purpose of which is to account for low probability, high-cost climate damage scenarios. The Canadian Working Group decided not to include results from the FUND model in determining the 95th percentile.[101] Reasoning for this is sparse, with the Technical Document only stating "the model does not incorporate the low-probability, high-cost events that the 95th percentile is meant to address."[102] No further attention is given to why the U.S. Working Group would choose to use this value. As summarized in Table 2 below, this difference in practice has led Canada and the United States to have significantly different 95th percentile SCC estimates—with the U.S. value at $117.6, while Canada's is at $167.[103]

Third and finally, the Canadian Working Group adjusts U.S. SCC estimates based on differences in currency and GDP. Of the three adjustments, and unlike the other two, this adjustment alone is properly characterized as "minor." Close interrogation is not undertaken, though it is noted that Canada's widely fluctuating currency in recent years could introduce another reason to be wary of the wholesale adoption of U.S. work.

Together, the Canadian adjustments, particularly those pertaining to discount rates and the 95th percentile SCC values, represent relatively significant differences in practice that have an impact both in terms of specific SCC analyses in regulatory CBA and with respect to how the present examination of SCC in Canada and the United States may confirm broader critiques about SCC and CBA generally.

Before turning to that discussion, the next sections present a detailed review of the use of SCC in the regulatory impact analyses of two specific initiatives. Similarities and differences between the Canadian and U.S. approaches are notable throughout. To set up this discussion, Table 2 summarizes initial and current SCC values generated by Canada and the United States. This snapshot succinctly illustrates several key points that flow from the differences described above: Canada only uses two SCC values while the United States uses four (this is linked to Canada using only one discount rate while the United States uses three), Canada's 95th percentile is different from that of the United States

99. ECCC TECHNICAL DOCUMENT, *supra* note 7, at 13.

100. Not a flattering decision by the Canadians in this regard. For a full discussion, see *infra* section III.D.

101. ECCC TECHNICAL DOCUMENT, *supra* note 7, at 22.

102. *Id.* at 13.

103. Both of these values are for the year 2016 and are expressed in Canadian dollars 2012/ton of CO_2.

(because of Canada's omission of the FUND model), and the current "central value" is the same for both Canada and the United States—$40.7 in the year 2016 and expressed in year 2012 Canadian Dollars per tonne of CO_2 (due to Canada directly adopting that U.S. value, which is linked to the 3% discount rate).

TABLE 2
U.S. AND CANADIAN SCC VALUES[104]

	U.S.	Canada
Initial SCC values	Initial U.S. Working Group estimates of SCC issued in 2010: $4.7, $21.4, $35.1, $64.9. These values are for the year 2010 and are expressed in year 2007 U.S. Dollars per tonne of CO_2 at discount rates of 5%, 3%, 2.5% and the 95th percentile of 3%, respectively.[105]	Initial Canadian WG estimates of SCC issued in 2011: $25.6, $100.9. These values are for the year 2010 and are expressed in year 2009 Canadian Dollars per tonne of CO_2 at a discount rate of 3% and the 95th percentile of 3%, respectively.[106]
Current SCC values	U.S. Working Group 2015 updated SCC values: $12.2, $40.7, $62.3, $117.6.[107] These values are for the year 2016 and are expressed in year 2012 Canadian Dollars per tonne of CO_2 at discount rates of 5%, 3%, 2.5% and the 95th percentile of 3%, respectively.	Canadian Working Group 2016 updated SCC values: $40.7, $167.0.[108] These values are for the year 2016 and are expressed in year 2012 Canadian Dollars per tonne of CO_2 at a discount rate of 3% and the 95th percentile of 3%, respectively.[109]

104. Values here are expressed in the using the years, values, discount rates and units that appear in relevant Canadian and U.S. guidance. To ensure accuracy of the figures, no conversions of years, currency exchange rates or any other parameters have been changed. Unfortunately, this makes it more challenging to interpret differences across units. However, for the most recent values, the Canadian guidance has included a table of U.S. figures converted into Canadian Dollars. Those values appear in the bottom row of this table. This table is included here primarily for the purpose of demonstrating the evolution in Canada and the U.S. of SCC values in relation to each other.

105. ECCC TECHNICAL DOCUMENT, *supra* note 7, at 9. Note that values for the year 2016 would be $6, $24.3, $39.1, $74.4.

106. *Id.* at 15. Note that values for the year 2016 would be $29.1 and $115.7.

107. *Id.* at A-1 (table of U.S. SCC values expressed in 2012 Canadian dollars).

III. SOCIAL COST OF CARBON IN CANADA & U.S. GHG REGULATORY DECISION-MAKING

To demonstrate and examine how Canada and the United States each develop SCC values and employ them in regulatory decision-making, this section sets out a detailed analysis of two specific sectors: regulation of emissions from coal-fired electricity generators and regulation of emissions from light-duty vehicles. Selecting these two areas of regulation provides an optimal set of information for the purposes of the present analysis for several reasons. First, the regulatory action focuses on the same sectors in each country. Second, the regulatory decision-making was conducted reasonably close in time (generally within less than three years of each other). Third, the regulatory decision-making represents some of the most recent from both countries (noting that Canada does not have a particularly large set of federal regulations to choose from and has not taken any new steps since 2014).

A. SOCIAL COST OF CARBON & THE UNITED STATES' FEDERAL REGULATIONS FOR LIGHT-DUTY VEHICLE EMISSIONS

In October 2012, the United States put in place the 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards.[110] These were the second phase of standards for this sector, building on previous EPA regulations.[111] The standards apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles (such as sport utility vehicles, cross-over utility vehicles, and light trucks). The main purpose of the regulations is to reduce GHGs and improve fuel economy.[112] Quantitatively, as stated in the final rule, these standards are projected to limit, on an average industry fleet-wide basis, CO_2 emissions in model year 2025 vehicles to 163 grams/mile—equivalent to 54.5 mpg if this level were achieved solely through improvements in fuel efficiency.[113]

108. *Id.* at 27.

109. Note that the "central values" for Canada and the United States are identical. This is significant because it is this value that is used to reach conclusions in the cost-benefit analysis. Note also that the 95th percentile value is actually different. This is because, as has been explained in preceding paragraphs, Canada choses to leave out results from the FUND model, which the United States does include in its 95th percentile calculations.

110. 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624 (October 15, 2012) (to be codified at 40 C.F.R. pts. 85, 86, 600, and 49 C.F.R. 531, 533, 536, 537).

111. Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011-2015, 73 Fed. Reg. 24,352-01 (May 2, 2008).

112. 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. at 62,626–27.

113. *Id*. at 62,627, *see also* 40 CFR 86.1818-12.

As required, the federal regulatory development process included publication of an RIA, which contained a CBA and employed the SCC.[114] The RIA cites the work of the U.S. Working Group and indicates that the CBA employs the four SCC values generated by the working group: $5, $22, $37, and $68 per metric ton of carbon emissions in the year 2010, in 2010 dollars.[115] The RIA explains that the first of these three values is based on the average SCC from three integrated assessment models, at discount rates of 5%, 3%, and 2.5%, respectively. It goes on to provide more context around why more than one discount rate is used:

> SCCs at several discount rates are included because the literature shows that the SCC is quite sensitive to assumptions about the discount rate, and because no consensus exists on the appropriate rate to use in an intergenerational context. The fourth value is the 95th percentile of the SCC from all three models at a 3 percent discount rate. It is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. Low probability, high impact events are incorporated into all of the SCC values through explicit consideration of their effects in two of the three models as well as the use of a probability density function for equilibrium climate sensitivity in all three models. Treating climate sensitivity probabilistically allows the estimation of SCC at higher temperature outcomes, which lead to higher projections of damages.[116]

The RIA also includes cautionary comments with respect to limitations inherent in the use of SCC. For example it states that, "any effort to quantify and monetize the harms associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional."[117] More specifically the RIA points out, citing the U.S. Working Group, that SCC analysis is limited by the incomplete way in which the IAMs capture catastrophic and non-catastrophic impacts, their model's incomplete treatment of adaptation and technological change, uncertainty in the extrapolation of damages due to high temperature, and assumptions regarding risk aversion.[118] Notwithstanding the fundamental nature of these limitations, the RIA then proceeds to engage in a detailed CBA relying on SCC values and associated benefits.

In its analysis, the RIA also includes monetized values for benefits other than carbon emission reductions including energy security, time saved by less refueling, non-GHG-related health impacts (such as reduced exposure to particulate

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114. ENVTL. PROT. AGENCY, EPA-420-R-12-016, REGULATORY IMPACT ANALYSIS: FINAL RULEMAKING FOR 2017-2025 LIGHT-DUTY VEHICLE GREENHOUSE GAS EMISSION STANDARDS AND CORPORATE AVERAGE FUEL ECONOMY STANDARDS (2012) [hereinafter U.S. MY 2017 AND LATER RIA].

115. *Id.* at 7-3.

116. *Id.*

117. *Id.* at 7-4.

118. *Id.*

matter),[119] and non-CO_2 greenhouse gas impacts (such as reduced greenhouse effect due to reduced methane, nitrous oxide, and hydrofluorocarbons).[120] These values are calculated and included in the overarching tally of benefits expected from the regulation.

The RIA presents, in tabular format, a comprehensive summary of the benefits expected from the regulation.[121] As part of this summary, the RIA presents four different SCC values (based on the three different discount rates and the 95th percentile value) and a single monetized value for non-SCC benefits. All benefits are then calculated and set out using a 3% and 7% discount rate, as is required by Circular A-C4 for all U.S. CBA.[122] As explained in the RIA, "[n]et present value of reduced CO_2 emissions is calculated differently than other benefits. The same discount rate is used to discount the value of damages from future emissions (SCC at 5, 3, 2.5%) is used to calculate net present value of SCC for internal consistency."[123]

An all-encompassing quantitative analysis for this regulation is based on the net benefits associated with the lifetimes of 2017–2025 model light-duty vehicles at a 3% overall discount rate and a 3% SCC discount rate state the total annual benefit to $451,000 million (2010 US$), of which $46,600 (2010 USD), or approximately 10.3%, is attributed to SCC.[124] This analysis also states that at a 7% overall discount rate and a 3% SCC discount rate, the total annual benefit would be $326,000 million (2010 USD), of which $46,600 million (2010 USD), or approximately 14.3%, is attributed to SCC.[125]

The RIA illustrates several points. First, the U.S. uses four different SCC values, flowing from three different discount rates and the 95th percentile of the estimate at a 3% discount rate. This practice is explicitly tied to the acknowledged sensitivity of SCC to discount rates and the lack of consensus around the appropriate rate to use given intergenerational dimensions. Second, the SCC value clearly represents a significant portion of the benefits expected from this regulation—10.3% or 14.3% depending on discount rate. Third, SCC weighs heavily in the calculation of benefits despite fundamental critiques and limitations acknowledged in the RIA. Fourth, presenting SCC in association with three

119. *Id* at 7-27.

120. The RIA engages in a detailed discussion about valuation of non-CO_2 GHG impacts, acknowledging challenges in this area. It concludes that, "in the absence of direct model estimates from the interagency analysis, the EPA conducted a sensitivity analysis using the GWP approach [which is conversion of reductions of non-CO_2 GHG emissions into CO_2 equivalent values, recognizing that different gases have different greenhouse effect forcings] to estimate the benefits associated with reductions of three non-CO_2 GHGs in each calendar year." *Id*. at 7-7.

121. *Id.* at ii, 7-26–7-30.

122. *Id.* at 7-27–7-28. Note that OMB's Circular A-4 (2003) requires the use of constant 3 percent and 7 percent. *See* OFFICE OF MGMT. & BUDGET, *supra* note 29, at 33.

123. *Id.* at 7-27–7-28.

124. *Id*. at 7-28.

125. *Id.*

different discount rates provides it treatment different from other benefits, which are presented using only two different discount rates. These observations will be revisited below in comparison to Canada.

B. SOCIAL COST OF CARBON & CANADA'S FEDERAL REGULATIONS FOR LIGHT-DUTY VEHICLE EMISSIONS

In 2014, Canada promulgated the Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations as a second phase of regulations in the transportation sector. In announcing the new regulations, the federal government acknowledged that they contributed to a broader project aligning the U.S. and Canadian transportation emission regulations.[126] These regulations built on the existing 2010 regulations,[127] increasing the stringency of emission standards for Canadian vehicles of model years 2017–2025. The regulations adopt precisely the same quantitative emissions standards as those discussed above in the U.S. context. The U.S. regulatory standards are incorporated by explicit reference throughout the Canadian regulations, most notably in the definitions in Section 1 and in Section 16 specifically with respect to CO_2 emission standards.[128] The stated rationale for such equivalency, in addition to aligned action on climate change, is to provide regulatory certainty, minimize administrative burden, and preserve competitiveness of the Canadian auto sector given the high level of integration within the industry.[129]

As required, the regulatory development process includes publication of an RIAS, which contains a CBA and employs the SCC. The RIAS explains that the SCC "represents an estimate of the economic value of avoided climate change damages at the global level for current and future generations as a result of reducing GHG emissions" and that it was used in the CBA to quantify the benefits of reducing GHG emissions.[130] It goes on to explain that the SCC values used in the CBA are "based on the extensive work of the U.S. Interagency Working Group on the Social Cost of Carbon."[131] The RIAS indicates that SCC values

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126. News Release, Gov't of Canada, Government of Canada Takes Further Action to Reduce Greenhouse Gases (GHGs) and Air Pollution from Cars and Trucks (Sep. 22, 2014), http://www.newswire.ca/news-releases/government-of-canada-takes-further-action-to-reduce-greenhouse-gases-ghgs-and-air-pollution-from-cars-and-trucks-515683321.html.

127. Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations, SOR/2010-201 (Can.) [hereinafter Canadian Light Duty Vehicle Regulations].

128. *Id.* subsection 1(1): "CFR means the Code of Federal Regulations of the United States as amended from time to time." The substantive U.S. emission standards are then incorporated by reference in sections 10 (dealing with Nitrous oxide and methane emission standards), 16 (Fleet Average CO_2 Equivalent Emission Standards). *Id.*

129. Gov't of Canada, Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations Regulatory Impact Analysis Statement, SOR/2014-207 at Part 6 (Can.) [hereinafter Canada Light Duty Vehicles RIAS].

130. *Id.* at Part 7.

131. *Id.*

also draw on ongoing work being undertaken by the ECCC in collaboration with an interdepartmental federal government technical committee, and in consultation with a number of external academic experts.[132]

The RIAS includes two quantitative values based on a discount rate of 3% and the 95th percentile of the 3% discount rate values: $29.38 and $116.45 (per tonne of CO_2 in 2013).[133] As discussed above, this differs from the U.S approach of using three different discount rates and four separate SCC values. In selecting these two values, the RIAS concludes that, "it is reasonable to estimate SCC values at a central value of $29.38/tonne of CO_2 in 2013 up to $62.69 in 2056"; and:

> [A] value of $116.45/tonne in 2013 up to $246.83 in 2056 should be considered . . . [to] reflect a 95th percentile value on a right-skewed probability distribution, and arguments raised by Weitzman (2011) and Pindyck (2011) . . . [whose] argument calls for full consideration of low probability, high-cost climate damage scenarios in cost-benefit analyses to more accurately reflect risk.[134]

Finally, the RIAS acknowledges that a "value of $116.45 per tonne does not, however, reflect the extreme end of SCC estimates, as some studies have produced values exceeding $1,000 per tonne."[135] There is no discussion or rationale regarding the use of two SCC values instead of four.

In summarizing the "key results," the RIAS includes conclusions on the "net benefit" of the proposed regulation. This figure was calculated to set out "net benefits for each model year, beginning with a $1.1 billion net benefit for the lifetime of model year 2017 vehicles and $9.2 billion for model year 2025 vehicles, totaling $49.0 billion in net benefits over the lifetime operation of all model year 2017 to 2025 vehicles in Canada."[136] The RIAS further states that overall, the amended regulations were expected to result in a "benefit-to-cost ratio" of more than five-to-one over the lifetime operation of all model year 2017 to 2025 vehicles in Canada.[137]

These grand totals are based on an SCC value of $29/tonne, which represented the "central figure" used in the RIAS. Relevant calculations in the RIAS show that the quantified benefits flowing from SCC calculations were $4.4 billion dollars. This represents approximately 9% of the expected $49 billion in net benefits. Clearly SCC carries a significant weight in the net benefits calculation.

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132. *Id.*
133. *Id.*
134. *Id.*
135. *Id.*
136. *Id.*
137. *Id.*

Similar to observations in the U.S. context, the figures in the Canadian RIAS reveal several notable points. First, Canada chooses to use just two SCC values based on a single discount rate, unlike the U.S. approach of four values based on three discount rates. No rationale is provided for this decision, though this is in line with the approach outlined in the Canadian Working Group technical document that pointed to concerns around four sets of figures being "too challenging" for Canadian decision-makers. Second, SCC represents a significant proportion of total benefits from the regulatory action (approximately 9%). Third, relatively heavy weight is accorded to SCC in cost-benefit calculations despite acknowledged critiques and limitations. Finally, Canada uses only one discount rate (3%) for the broader CBA, which differs from the U.S. practice of using two discount rates for the CBA (3% and 7%). The table below presents a side-by-side summary of this situation for these specific regulations.

TABLE 3
SUMMARY OF CANADA AND U.S. USE OF CBA AND SCC FOR LIGHT DUTY VEHICLE EMISSIONS

	U.S.	Canada
Regulation	Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards (2017–2025)	Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations (2017–2025)
Date of Regulatory Impact Analysis	August 2012	December 2012
Purpose of Regulatory Action	Second phase vehicle emissions reductions	Second phase vehicle emission reductions in alignment with EPA standards
Regulatory Standard	163 grams/mile of CO_2 in model year 2025—40 CFR 86.1818–12	163 grams/mile of CO_2 in model year 2025—40 CFR 86.1818–12
SCC Values	$5, $22, $37 and $68 (per tonne of CO_2 in the year 2010, in 2010 US$)[138]	$29 and $116 (per tonne of CO_2 in 2013, in 2012 C$)[139]
SCC Discount rates	5%, 3%, 2.5%, and 95th percentile of 3%	3% and 95th percentile of 3%
CBA Discount rate(s)	3% and 7%	3%
Proportion of benefits attributed to SCC	Approximately 10.3% ($46.6 billion of $451 billion), using the SCC "central value" (3% discount rate) and overall CBA discount rate of 3% Approximately 14.3% ($46.6 billion of $326 billion), using the SCC "central value" (3% discount rate) and overall CBA discount rate of 7%	Approximately 9% ($4.4 billion of $49 billion), using the SCC "central value" (3% discount rate) and an overall CBA discount rate of 3%

	U.S.	Canada
Differences in approaches	U.S. used four SCC values based on three discount rates	Canada used two SCC values based on one discount rate
	U.S. used two discount rates (3% and 7%) for broader CBA	Canada used one discount rate (3%) for broader CBA
	SCC represents approximately 10.3–14.3% of net benefits (depending on overall CBA discount rate)	SCC represents approximately 9% of net benefits
	Non-SCC benefits included pre-tax fuel savings, energy security benefits, refueling time savings, and related health impacts.	Non-SCC benefits included pre-tax fuel savings, reduced fueling time, and additional driving

C. SOCIAL COST OF CARBON & THE UNITED STATES' FEDERAL REGULATIONS FOR COAL-FIRED POWER PLANTS

Regulating emissions from coal-fired power plants has been a slow process for the U.S. federal government. In March 2012, the EPA announced a proposed carbon pollution standard for new power plants.[140] However, after receiving more than 2.5 million comments,[141] the EPA withdrew the proposal and issued a revision in September 2013[142] in conjunction with President Obama's 2013 Climate Action Plan.[143] The regulatory picture has continued to evolve since then,[144] eventually leading to the EPA's release of the Final Rule for Carbon Pollution Standards for New, Modified and Reconstructed Power Plants in October 2015,[145] as well as the Clean Power Plan, released in late

138. U.S. MY 2017 AND LATER RIA, *supra* note 114, at 7-3.

139. Canada Light Duty Vehicles RIAS, *supra* note 129, at Part 7.

140. Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, 77 Fed. Reg. 22392 (April 13, 2012) (to be codified at 40 C.F.R pt. 60).

141. *See* Withdrawal of Proposed Standards of Performance for Greenhouse Gas Emissions From New Stationary Sources: Electric Utility Generating Units 79 Fed. Reg. 1352, 1352 (Jan 8. 2014) (to be codified at 40 C.F.R. pt 60).

142. ENVTL. PROT. AGENCY, EPA-452/R-13-003, REGULATORY IMPACT ANALYSIS FOR THE PROPOSED STANDARDS OF PERFORMANCE FOR GREENHOUSE GAS EMISSIONS FOR NEW STATIONARY SOURCES: ELECTRIC UTILITY GENERATING UNITS (Sep. 2013), https://www.epa.gov/sites/production/files/2013-09/documents/20130920proposalria.pdf.

143. EXECUTIVE OFFICE OF THE PRESIDENT, THE PRESIDENT'S CLIMATE ACTION PLAN (June 2013), https://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf.

144. For a succinct chronological summary, see U.S. EPA, FACT SHEET: CARBON POLLUTION STANDARDS (Sep. 2015), https://19january2017snapshot.epa.gov/cleanpowerplan/fact-sheet-clean-power-plan-carbon-pollution-standards-key-dates.html.

145. Standards of Performance for Greenhouse Gas Emissions From New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units, 80 Fed. Reg. 64,510 (Oct. 23, 2015) (to be codified at 40 C.F.R. pts. 60, 70, 71 & 98). The fate of the Clean Power Plan is currently tied up in litigation, Order Granting Motion to Hold Cases in Abeyance, West Virginia v. EPA, No. 15-1363 (D.C. Cir. Apr. 28, 2017), although the Trump administration has indicated its intention to do away with the Clean Power Plan in its entirety, Exec.

2015.[146] The focus in the present discussion is on the RIA issued as part of this Final Rule for New, Modified and Reconstructed Power Plants, as it provides the most relevant regulatory action for comparative purposes with Canada—due to Canada's regulation primarily dealing with new and end-of-life power plants.

In August 2015, pursuant to requirements set out in Executive Order 12866, the EPA issued the Regulatory Impact Analysis for the Final Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units.[147] Similar to the approach explained below in the Canadian context, the proposed rule applies a performance standard with a specific emissions intensity level. The rule includes standards for both natural gas-fired and coal-fired power plants, though the focus here, for purposes of comparison with Canada, is on the standard for coal-fired power plants. The rule sets a performance standard for newly constructed plants of 1400 lbs. CO_2/MWh.[148] As explained in the RIA, this standard is consistent with the requirements of Clean Air Act Sections 111(a) and (b) and reflects "the degree of emission limitation achievable through the application of the best system of emission reduction (BSER) that the EPA has determined has been adequately demonstrated for each type of unit."[149]

Chapter 3 of the RIA presents an analysis of the benefits of reducing GHGs and other pollutants. SCC is a central part of this discussion. The RIA explains SCC and why it is used:

> The social cost of carbon is a metric that estimates the monetary value of impacts associated with marginal changes in CO_2 emissions in a given year. It includes a wide range of anticipated climate impacts, such as net changes in agricultural productivity and human health, property damage from increased flood risk, and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning. It is typically used to assess the

Order No. 13,783, 82 Fed. Reg. 16093, 16095 (Mar. 28, 2017).

146. Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units; Final Rule, 80 Fed. Reg. 64,661–65,120 (Oct 23, 2015) (to be codified at 40 C.F.R. pt. 60) [hereinafter Clean Power Plan]. The EPA and most others involved refer to this as the Clean Power Plan ("CPP"). The CPP is mentioned here to provide the broader context; however, the analytical focus will be on the standards for new, modified and reconstructed plants, as those bear the closest resemblance to the Canadian regulations.

147. ENVTL. PROT. AGENCY, EPA-452/R-15-005, REGULATORY IMPACT ANALYSIS FOR THE FINAL STANDARDS OF PERFORMANCE FOR GREENHOUSE GAS EMISSIONS FROM NEW, MODIFIED, AND RECONSTRUCTED STATIONARY SOURCES: ELECTRIC UTILITY GENERATING UNITS (Aug. 2015). [hereinafter EPA RIA FOR NEW SOURCES].

148. As explained in the EPA RIA, this standard is set at the emissions level achievable by newly constructed steam generating units that use supercritical pulverized coal with post-combustion partial CCS technology. The U.S. standard of 1,400 lb CO_2/MWh gross is the same as 635 tonnes of CO_2/GWh. Canada uses the latter way of expressing this standard. So, to compare directly, the U.S. standard is 635 tonnes of CO_2/GWh compared to the Canadian standard of 420 tonnes of CO_2/GWh. For this conversion, see INT'L ENERGY AGENCY GREENHOUSE GAS R&D PROGRAMME, *Emissions Performance Standards—For or Against,* Information Paper: 2015-IP29, 3 (2015), http://www.ieaghg.org/docs/General_Docs/Publications/Information_Papers/2015-IP29.pdf.

149. EPA RIA FOR NEW SOURCES, *supra* note 147, at ES-2.

> avoided damages as a result of regulatory actions (i.e., benefits of rulemakings that lead to an incremental reduction in cumulative global CO_2 emissions).[150]

The RIA goes on to explain that the SCC values used were those generated by the U.S. Working Group, citing the Group's technical updates in 2010, 2013, and 2015.[151] Notably, and similar to the RIA for light-duty vehicle emissions regulations, the RIA acknowledges limitations inherent in SCC analysis.[152]

Once again, the EPA used four SCC values in this RIA: $13, $41, $62 and $120 per short ton of CO_2 emissions in the year 2022 (in 2011 dollars).[153] These updated values are based on the most recent U.S. Working Group technical guidance. The first three values are based on the average SCC from the three IAMs, at discount rates of 5%, 3%, and 2.5%, respectively. The RIA again explains that SCC estimates for several discount rates are included because the literature shows that SCC is sensitive to assumptions about discount rates, and because "no consensus exists on the appropriate rate to use in an intergenerational context (where costs and benefits are incurred by different generations)."[154] The fourth value of $120 is the 95th percentile estimate at a 3% discount rate. Similar to the basis described in other Canadian and U.S. analyses, its inclusion is explained to represent less likely but potentially catastrophic climate impacts.[155]

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150. *Id*. at 3-2, 3-3.

151. *Id.* at 3-3.

152. *Id. at* 3-4–3-5. The coverage of this issue is relatively thorough. The RIA cites the U.S. Working Group technical work acknowledges the following:

> The 2010 SC-CO_2 TSD noted a number of limitations to the SC-CO_2 analysis, including the incomplete way in which the integrated assessment models capture catastrophic and non-catastrophic impacts, their incomplete treatment of adaptation and technological change, uncertainty in the extrapolation of damages to high temperatures, and assumptions regarding risk aversion. Current integrated assessment models do not assign value to all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature due to a lack of precise information on the nature of damages and because the science incorporated into these models understandably lags behind the most recent research. The limited amount of research linking climate impacts to economic damages makes the modeling exercise even more difficult.

153. *Id.* at 3-6. Note that these units are short tons, but RIA footnote 'a' on page 3-7 explains that:

> [V]alues are stated in $/short ton and rounded to two significant figures. Unrounded estimates from the current TSD have been converted from $/metric ton to $/short ton using conversion factor 0.90718474 for consistency with this rulemaking and adjusted to 2011$ using the GDP Implicit Price Deflator (1.0613744). This calculation does not change the underlying methodology nor does it change the meaning of the SC-CO2 estimates.

This differs from Canadian straight up use of metric tonnes. Direct comparisons remain a challenge. However, as discussed elsewhere in this Article, the 2016 Technical Update provides conversion table that allows for direct comparison of the most recent U.S. and Canadian values. In the interest of accuracy, this Article has not engaged in an exercise of converting figures into common units and years. Rather, all figures are as stated in regulatory documents unless otherwise indicated.

154. *Id.* at 3-7.

155. *Id.* at 3-7.

Unlike the Canadian RIAS and the U.S. RIA for light-duty vehicle emissions regulation, this U.S. RIA does not include an all-encompassing cost-benefit statement. However, Chapter 5 includes a detailed analysis of incremental benefits of emission reductions from compliant coal-fired generation that meets the final rule's performance standard of 1400 lbs/MWh, and in doing so, it takes an approach similar to that in the light-duty vehicle RIA. Specifically, the RIA analysis uses all four SCC values (based on the three discount rates and 95th percentile) while also factoring in non-CO_2 related benefits.[156] It goes on to evaluate the range of potential impacts per MWh by presenting all SCC values in relation to the non-CO_2 benefits at the 3% and 7% discount rates required for all U.S. CBAs.

This RIA also reveals several points salient to the present Canada-U.S. comparative discussion. First, it provides another example of the use of four different SCC values throughout the SCC analysis and throughout the broader CBA. Second, it is another example of the use of three different discount rates throughout the SCC analysis as well as the broader CBA. Third, the RIA is one more instance of the use of two different discount rates in the broader CBA, including as applied to SCC benefits. Fourth, the RIA is again an example where caution is issued with respect to SCC limitations and challenges. Finally, all of these points are similar in kind to those observed in the light-duty vehicle emissions regulation RIA, suggesting that this is common practice.[157]

D. SOCIAL COST OF CARBON & CANADA'S FEDERAL REGULATIONS FOR COAL-FIRED POWER PLANTS

In 2013, Canada's federal government promulgated the Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations.[158] These regulations apply a performance standard to new coal-fired electricity generation units, and units that have reached the end of their useful life (typically around 50 years).[159] The performance standard came into effect on July 1st, 2015 and is set at the emissions intensity level of Natural Gas Combined Cycle technology (a high-efficiency type of natural gas generation).[160] Specifically, the

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156. In the power plant context, these are PM2.5-related benefits from SO_2 and NO_X emissions changes.

157. Indeed, review of other RIAs shows the same approach on these points. *See, e.g.*, ENVTL. PROT. AGENCY, EPA-420-R-16-900, PROPOSED RULEMAKING FOR GREENHOUSE GAS EMISSIONS AND FUEL EFFICIENCY STANDARDS FOR MEDIUM- AND HEAVY-DUTY ENGINES AND VEHICLES—PHASE 2 DRAFT REGULATORY IMPACT ANALYSIS 8-34–8-39 (August 2016).

158. Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations, SOR/2012-167 (Can.).

159. GOV'T OF CANADA, REDUCTION OF CARBON DIOXIDE EMISSIONS FROM COAL-FIRED GENERATION OF ELECTRICITY REGULATIONS REGULATORY IMPACT ANALYSIS STATEMENT, at Part 5, http://www.gazette.gc.ca/rp-pr/p2/2012/2012-09-12/pdf/g2-14619.pdf#page=68 [Hereinafter, CANADIAN COAL-FIRED ELECTRICITY REGULATIONS RIAS].

160. *Id.*

performance standard is fixed at 420 tonnes of carbon dioxide per gigawatt hour (tonnes of CO_2/GWh).[161]

As part of the regulatory development process described above in Part I, in August 2012 the Canadian government published a RIAS, which contained a CBA that employed the SCC.[162] As stated in the RIAS, the purpose of the CBA was to "describe the major policy and modeling changes and present the expected impacts stemming from the revised analysis."[163] It employed the federal government's standard approach to CBA, which is to "to identify, quantify and monetize the incremental costs and benefits of the Regulations."[164]

A core part of the discussion of benefits in the RIAS was the SCC analysis, which was described as "[t]he value placed on anticipated climate change damages."[165] This RIAS once again used just two SCC values: $26 and $140 (per tonne of CO_2 in 2010 Canadian Dollars).[166] The RIAS explained the basis for these SCC values:

> [B]ased on current literature and in line with the approach adopted by the U.S. Interagency Working Group on the Social Cost of Carbon . . . it is reasonable to estimate SCC values at $26/tonne of CO_2 in 2010, increasing at a given percentage each year associated with the expected growth in damages. Environment Canada's review also concluded that a value of $104/tonne in 2010 should be considered for sensitivity analysis, reflecting arguments raised by Weitzman (2011) and Pindyck (2011) regarding the treatment of right-skewed probability distributions of the SCC in cost-benefit analyses. Their argument calls for full consideration of low probability, high-cost climate damage scenarios in cost-benefit analyses to more accurately reflect risk. A value of $104 per tonne does not, however, reflect the extreme end of SCC estimates, as some studies have produced values exceeding $1,000 per tonne of carbon emitted.[167]

Similar to the RIAS for light-duty vehicle emissions, this RIAS did not include discussion or justification for using two SCC values instead of four.

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161. *Id*. This level of stringency has the effect of precluding the building of any new coal plants; however, because it applies only to new plants and those at the end of useful life, the regulation has been criticized for not being stringent enough. *See* JASON DION ET AL., INT'L INST. FOR SUSTAINABLE DEV., POLICY BRIEF, A CLIMATE GIFT OR A LUMP OF COAL? THE EMISSION IMPACTS OF CANADIAN AND U.S. CREENHOUSE GAS REGULATIONS IN THE ELECTRICITY SECTOR (Sep. 2014), http://www.iisd.org/sites/default/files/publications/climate-gift-or-lump-of-coal.pdf. *See also*, P.J. Partington, *Who's really winning the race to end coal? A comparison of Canada and U.S. federal regulations*, PEMBINA INST. BLOG (Feb. 22, 2013), http://www.pembina.org/blog/691.

162. CANADIAN COAL-FIRED ELECTRICITY REGULATIONS RIAS, *supra* note 159.

163. *Id.* at 2019.

164. *Id.* at 2040.

165. *Id.*

166. *Id*.

167. *Id*. It should be noted that in sub-Part 7.6.1 regarding sensitivity analysis, the RIAS states that cost-benefit results were most sensitive to "varying the discount rate, using the avoided SCC at the 95th percentile estimate." *Id*. at 2058.

The RIAS went on to conclude that based on the "central value" of $26/tonne in 2010, the "present value of the incremental GHG emission reductions from the utility sector under the Regulations is estimated to be $5634 million."[168] This value was then rolled into an all-encompassing "cost-benefit statement" that summarized all dimensions the following way:

> [T]he NPV of the Regulations in 2015 over the study period is estimated at $7.3 billion. The present value of benefits is estimated at $23.3 billion, largely due to the avoided costs of climate change ($5.6 billion), avoided generation costs ($7.2 billion), health benefits from reduced smog exposure ($4.2 billion), and additional oil extracted through enhanced oil recovery ($6.1 billion). The present value of costs is estimated at $16.1 billion, largely due to incremental purchase of natural gas fuel ($8.0 billion), oil extraction costs for enhanced oil recovery ($1.3 billion), reduced exports ($0.3 billion) and new capital ($1.9 billion).[169]

The RIAS reveals several notable points. First, it provides another example of Canada using just two SCC values in the SCC analysis. Second, it is another example of Canada using only one discount rate throughout the SCC analysis. Third, it is another example of Canada using a single discount rate in the broader CBA, including as applied to SCC benefits. Fourth, similar to the U.S. context, this RIAS is another instance where caution is issued with respect to SCC limitations and challenges, but SCC values are nonetheless heavily factored into the broader CBA anyway. Fifth, with a benefit of $5.6 billion, which is roughly equal to 25% or total benefits, the SCC constitutes a significant portion of the benefits expected from this regulation. Finally, all of these points are similar in kind to those observed in the light-duty vehicle emissions regulation RIAS, suggesting that these practices are common practice in Canadian analyses.[170] The table below presents a side-by-side summary of these specific regulations.

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168. *Id.*

169. *Id.* at 2019.

170. Indeed, review of other RIAs shows the same approach on these points. *See, e.g.*, GOV'T OF CANADA, HEAVY-DUTY VEHICLE AND ENGINE GREENHOUSE GAS EMISSION REGULATIONS REGULATORY IMPACT ANALYSIS STATEMENT, Part 7.2.3 724 (April 2012), http://www.gazette.gc.ca/rp-pr/p2/2013/2013-03-13/pdf/g2-14706.pdf#page=74.

TABLE 4
SUMMARY OF CANADA AND U.S. CBA AND SCC FOR COAL-FIRED ELECTRICITY GENERATION REGULATIONS[171]

	U.S.	Canada
Regulation	Final Standards of Performance for Greenhouse Gas Emissions for New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units	Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations
Date of Regulatory Impact Analysis	August 2015	September 2012
Purpose of Regulatory Action	Set emission performance standards for from new, modified, and reconstructed fossil fuel-fired electric generating units constructed in the U.S.	Set emissions performance standards for new coal-fired electricity generation units and those that have reached the end of their useful life
Regulatory standard	635 tonnes of CO_2/GWh	420 tonnes of CO_2/GWh
SCC Values	$13, $41, $62 and $120 per short ton of CO_2 emissions in the year 2022 (in 2011 US$)	$26 and $104/tonne of CO_2 in 2010 (in 2010 C$)—$26 was used as the 'central value' and $104 was for sensitivity analysis
SCC discount rates	5%, 3%, 2.5%, and 95th percentile of 3%	3% and 95th percentile of 3%
CBA discount rate(s)	3% and 7%	3%
Proportion of benefits attributed to SCC	N/A (no overarching cost-benefit statement included in RIA)	Approx. 25% ($5.6 billion of $23 billion) using the SCC "central value" (3% discount rate) and an overall CBA discount rate of 3%
Differences in approaches	U.S. used four SCC values based on three discount rates	Canada used two SCC values based on one discount rate
	U.S. used two discount rates (3% and 7%) for broader CBA	Canada used one discount rate (3%) for broader CBA
	SCC represents approximately 10.3–14.3% of net benefits (depending on overall CBA discount rate)	SCC represents approximately 9% of net benefits
	Non-SCC benefits included pre-tax fuel savings, energy security benefits, refueling time savings, and PM2.5 related health impacts.	Non-SCC benefits included pre-tax fuel savings, reduced fueling time, and additional driving

IV. SIMILARITIES, DIFFERENCES, IMPLICATIONS & RECOMMENDATIONS

Similarities between Canadian and U.S. approaches to the development and use of SCC estimates are significant. At a fundamental level, this similarity is due to a basic commonality: both approaches use the work of the U.S. Working Group as the core basis for SCC estimates. As described above, the Canadian Working Group made a clear decision in 2011 to adopt U.S. SCC values and continued doing so for regulatory impact analyses of GHG emission regulations, as well as the latest SCC Technical Update released in March 2016. Yet, adopting the SCC values is only a superficial dimension of this commonality. Considered more deeply, this resemblance represents a common stance on the many inputs that go into IAMs, such as estimations of climate impacts, assumptions about catastrophic events, views on risk aversion, notions of substitutability of environmental goods, concerns about intra and inter-generation equity, and decisions about discount rates. One could even argue that this resemblance assumes a common view on the monetized value of a human life. Similarly, Canada's use of the U.S. Working Group estimates represents a common view on SCC as a global and not domestic value.[172]

Beyond the common basis for SCC values, Canada and the United States also share similar institutional approaches. Both countries' federal governments have put in place specialized working groups to act as expert bodies on the issue. Both countries have agencies or ministries that conduct regulatory impact analyses for proposed regulatory action and use SCC in this context—drawing on the work of the expert bodies in the process. It is also fair to say that both countries have a judiciary to oversee government action,[173] notwithstanding the fact that SCC is yet to be litigated in Canada.[174]

At a more detailed level, Canada and the U.S. similarly use CBA in regulatory decision-making, including use of SCC values as a key component in CBA. In both countries, SCC values are used to quantify the monetary benefits of the

171. Note that the regulations appearing side by side here do not have the exact same regulatory coverage. For analysis of the differences, see DION ET AL., *supra* note 161.

172. Some commentators argue that this is inappropriate and that SCC should be a domestic value. *See, e.g.*, Rowell, *supra* note 10.

173. This was seen in the case *Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin.*, 538 F.3d 1172 (9th Cir. 2008). Interestingly, a case has also recently come out at the state level. *See* Mark Wolski, *ALJ: Minnesota Should Use Federal Costs of Carbon in Decisions*, BLOOMBERG NEWS (Apr. 19, 2016), http://www.bna.com/alj-minnesota-federal-n57982070025/.

174. It is not difficult to imagine an application for judicial review of a federal decision to regulate a particular sector in which SCC is a key part of the regulatory analysis and justification. Given that the oil and gas sector and emissions-intensive, trade-exposed industries are yet to be regulated in Canada, this type of litigation is entirely foreseeable. Considering the recent decision in Minnesota, it will be interesting to see if similar proceedings are brought at the state and provincial level on respective sides of the border. Ontario and Alberta are obvious candidates, given the both have recently proposed provincial economy-wide carbon pricing legislation. *See* John Paul Tasker, *Here's where the Provinces Stand on Carbon prices*, CBC NEWS (Oct. 3, 2016), http://www.cbc.ca/news/politics/provinces-with-carbon-pricing-1.3789174.

proposed regulatory action and they are then factored into the broader quantitative calculation. While the legislative and administrative context differs to some degree, for example the U.S. CBA is required by Executive Order[175] where Canada's is required by Cabinet Directive,[176] the structure and substance are similar.

Finally, as the detailed review of regulatory impact statements above reveals, in both countries, the SCC carries substantial weight in the broader CBA despite agencies and working groups identifying fundamental limitations in SCC estimates. In this way, Canada and the United States share a significant overarching similarity: the decision to rely on SCC as a key tool in GHG regulatory decision-making. This reliance stands at variance, for example, with the United Kingdom, where carbon shadow pricing is used and values are linked to the countries quantitative emission reduction targets.[177]

While the sphere of commonality is significant, there are sharp and important differences that stand out, as is apparent from this Article's analysis. First, and returning for a moment to the institutional dimension, the U.S. has accomplished much more than Canada. It was a U.S. court that provided the impetus for use of SCC in regulatory decision-making.[178] The U.S. Working Group then led in the subsequent development and updates of SCC values.[179] Additionally, these updates have been more frequent in the U.S. Finally, U.S. work in this area has undergone some measure of independent scrutiny in the form of the 2014 U.S. GAO assessment[180] and the recently completed review by the U.S. National Academies of Sciences, Engineering and Medicine.[181] In sharp contrast, Canada has simply borrowed much of the U.S. Working Group's work, has only generated an initial set of SCC values with one subsequent update, has no court decision on the matter, and has had no independent institutional-level review. Though a rational and low-cost approach to the matter, Canada has quite clearly taken a free-rider approach to SCC. Indeed, the Canadian Working Group essentially stated as much when it reported that not adopting U.S. results would have "required significant investment by the Government of Canada" if it were to attempt the work itself.[182]

At a more granular level, significant differences are observable between Canadian and U.S. use of SCC estimates in specific CBAs. This is evidenced in the above detailed reviews of regulatory impact analyses and the technical

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175. U.S. Exec. Order No. 12,866, *supra* note 27.

176. GOV'T OF CANADA, *supra* note 44, at (G).

177. ECCC TECHNICAL DOCUMENT, *supra* note 7.

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

179. *See supra* Table 1.

180. GOV'T ACCOUNTABILITY OFFICE, *supra* note 30.

181. NAT'L ACADS. OF SCIS., ENG'G & MED., *supra* note 42.

182. ECCC TECHNICAL DOCUMENT, *supra* note 7.

documents of each country's expert working groups. For example, Canada does not include results of the FUND model in the 95th percentile SCC estimates. Minimal explanation is provided by Canada beyond the statement that the "FUND model does not incorporate the low-probability, high-cost events that the 95th percentile is meant to address."[183] While the basis for this decision is difficult to understand, especially if one considers that the U.S. takes a different view, implications of the difference can be readily observed by looking at the latest 95th percentile SCC values. The U.S. value is $117.6, while Canada's is $167. This means that if concurrent regulatory impact analyses were to take place at the present time, Canada's regulatory action may look comparatively more costly, or would at least give the impression that the range of potential costs is higher (in relation to a 3% discount rate). This, of course, relates to the most significant area of divergence between Canada and the United States—discount rates.

Certainly the clearest and most significant area of difference pertains to discount rates, including decisions about which to use for SCC estimates specifically, which associated SCC values to use, and which discount rates should be employed for the CBA more generally. These issues are particularly important due to the fact that, as an input to SCC models, discount rates have the single biggest impact on the estimates generated[184] and are often viewed as quasi-moral judgments because they determine how much burden is placed on future generations.[185]

Turning to the first of these discount rate issues, the starting point comes from the U.S. Working Group Technical Updates. The U.S. Working Group and U.S RIAs use three different discount rates based on the rationale that it is prudent to do so because SCC is so sensitive to assumptions about the discount rate, and because no consensus exists on the appropriate rate to use.[186] The use of three different discount rates in turn generates three different SCC estimates (plus a fourth based on the 95th percentile value of the 3% discount rate, as discussed above). Such an approach provides the public and policy-makers a relatively detailed view of potential benefits of regulatory action from different perspectives about what the future costs of climate impacts may be and how much of that cost should be borne by future generations. Canada, on the other hand, uses only one discount rate and generates a single SCC estimate (plus a second based on the 95th percentile value). In comparison to the United States, this is a much more limited view. Essentially, the Canadian public and policy-makers are not provided full information about the spectrum of potential regulatory benefits and

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183. *Id.* at 13.

184. Goulder & Williams, *supra* note 63; Weisbach & Cass Sunstein, *supra* note 97.

185. Bell & Callan, *supra* note 10; Revesz & Livermore, *supra* note 77; Ackerman & Heinzerling, *supra* note 82.

186. *See, e.g.*, U.S. MY 2017 AND LATER RIA, *supra* note 114; *see also*, U.S. WORKING GROUP TECHNICAL DOCUMENT, *supra* note 12.

potential climate impact scenarios and associated costs. As stated above, Canada's rationale is relatively thin, with the technical document simply stating that "it was felt that it would be challenging to present four sets of cost-benefit results to decision-makers."[187]

Such difference in the amount of information provided for regulatory analyses is multiplied when combined with Canada-U.S. differences in discount rates for the CBA more broadly. Similar to the SCC scenario, the United States uses two different discount rates, 3% and 7%, while Canada uses only one, 3%. This again means that the U.S. public and policy-makers are given more information upon which to understand regulatory impacts and associated decisions (and trade-offs). A direct comparison of excerpts of comparable data from Canada and U.S. regulatory impact analyses is illustrative here and presented in Table 5 and Table 6 (see further below). Put in simple terms, these tables show that the U.S. RIA provides quadruple the information as does the equivalent in the Canadian RIAS.

Differences observed between Canada and the United States beg questions about what these discrepancies mean and what should be done about them—implications that reverberate on three separate but interrelated levels: institutional, substantive, and procedural.

Institutionally, Canada appears to be in a relatively dependent and therefore weak position. While Canada has an expert working group in place, that group and regulators who are informed by its work, are almost entirely reliant on the work of the U.S. Working Group. The Canadian context is also not anchored to any court rulings that might underpin these administrative decisions. Similarly, Canada has not had any reviews by independent institutions in the likeness of the work of the U.S. GAO or the National Academies of Sciences, Engineering and Medicine. As U.S. SCC work faces possible dismantling in the wake of the 2016 U.S. election given the policies of the Trump Administration,[190] Canada may need to enhance its own efforts to forge ahead alone.

An obvious area for improvement is the strengthening of Canadian institutional arrangements and Canada-U.S. cooperation going forward, notwithstanding abovementioned change flowing from the U.S. election.[191] At the risk of following the leader once again, Canada might request an external review of its

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187. ECCC TECHNICAL DOCUMENT, *supra* note 7, at 13.

188. Note that the net benefit amounts include both benefits attributed to SCC and also non-CO_2 benefits such as pre-tax fuel savings and refueling time savings. Note that these figures are in Millions in 2012 C$. As such, these cannot be compared directly with the U.S. values above. Rather, this information is presented here for the sole purpose of demonstrating the significant difference in the amount of detailed information presented in U.S. versus Canadian regulatory impact statements.

189. Note that the net benefit amounts include both benefits attributed to SCC and also non-CO_2 benefits such as energy security, pre-tax fuel savings, and refueling time savings. It is in relation to the non-CO_2 benefits that the 3% or 7% CBA discount rate applies.

190. *See* Philips et al., *supra* note 38.

191. There have already been calls for improvements in the U.S. institutional approach. *See* Pizer et al., *supra* note 10.

TABLE 5

EXCERPTS FROM U.S. LIGHT-DUTY VEHICLE EMISSIONS REGULATIONS RIA SHOWING USE OF THREE SCC DISCOUNT RATES AND TWO CBA DISCOUNT RATES (FOR PURPOSES OF SHOWING LEVEL OF DETAIL PROVIDED IN U.S. TREATMENT OF SCC IN RIA)

Monetized Net Benefits[188] at each assumed SCC value at 3% CBA discount rate—U.S.										
Discount Rate	2017	2018	2019	2020	2021	2022	2023	2024	2025	Sum
5%	$5590	$13,000	$21,200	$30,500	$46,200	$57,500	$68,100	$79,700	$94,400	$416,000
3%	$6080	$14,100	$22,900	$33,000	$49,900	$62,200	$73,900	$86,600	$102,000	$451,000
2.5%	$6480	$15,000	$24,300	$34,900	$52,800	$66,000	$78,500	$92,000	$109,000	$479,000
3% at 95th percentile	$7400	$17,100	$27,600	$39,600	$59,800	$75,200	$89,800	$106,000	$125,00	$547,000

Monetized Net Benefits at each assumed SCC value at 7% CBA discount rate - U.S.										
5%	$3800	$9,010	$14,900	$21,600	$32,900	$40,300	$47,300	$55,100	$65,800	$291,000
3%	$4290	$10,100	$16,600	$24,100	$36,500	$45,000	$53,100	$62,000	$73,800	$326,000
2.5%	$4690	$11,000	$18,000	$26,000	$39,400	$48,800	$57,600	$67,400	$80,100	$353,000
3% at 95th percentile	$5610	$13,100	$21,300	$30,700	$46,500	$58,000	$69,000	$81,000	$96,100	$421,000

TABLE 6

EXCERPT FROM CANADIAN LIGHT-DUTY VEHICLE EMISSIONS REGULATIONS RIAS SHOWING USE OF THREE SCC DISCOUNT RATES AND TWO CBA DISCOUNT RATES (FOR PURPOSES OF SHOWING LEVEL OF DETAIL PROVIDED IN U.S. TREATMENT OF SCC IN RIA)

Monetized Net Benefits[189] at each assumed SCC value at 3% CBA discount rate—Canada										
Discount Rate	2017	2018	2019	2020	2021	2022	2023	2024	2025	Sum
3%	$1126	$2333	$3523	$4668	$5821	$6627	$7447	$8282	$9204	$49,031
3% at 95th percentile	$1397	$2920	$4421	$5869	$7334	$8399	$9483	$10,586	$11,805	$62,213

practices by a domestic body, perhaps by the Canadian Commissioner of the Environment and Sustainable Development or a special task force. Given the unexplained selectivity in Canada's SCC practices, it would be interesting to see what findings and recommendations would come from a review of this type, particularly given the significant room for improvement noted in the report of the U.S. National Academies of Sciences, Engineering and Medicine. Cooperation with the United States would wisely be a part of any Canadian efforts on this front. Despite the relatively more sophisticated position of the United States, collaboration would likely be mutually beneficial given the integrated nature of Canada-U.S. economies, climate policies, and climate impacts. For example, given that SCC has been treated as a global value, sharing Canadian and U.S. views on subjective model inputs like risk aversion and equity concerns may lead to improved representations of those dimensions in the modeling.

Substantively, the implications of Canada-U.S. differences are not easily discerned. On the one hand there is the peculiar scenario where different SCC values and practices still result in *identical* regulatory standards for emissions from light-duty vehicles (recalling that the Canadian regulation incorporates the U.S. standard by reference). On the other hand, different values appear to have been at least part of the analysis that led to different regulatory standards for new coal-fired power plants. Together, and notwithstanding above observations of SCC benefits constituting a range of 9%–25% in total regulatory benefits—outcomes that raise questions about whether the SCC has much of an impact on regulatory decision-making at all. Indeed, this is the kind of empirically-based argument recently put forward by Hahn & Ritz.[192] Clearly further research is needed, including more Canada-U.S. comparative work.

More immediately, however, and in terms of substantive dimensions, Canada ought to revisit the decision to select only a single discount rate and two SCC values. At the same time, it might reconsider why only one discount rate is used in the broader CBA, as opposed to two. The rationale for not using all four SCC values like in the United States is simply untenable given the reasons communicated. What is gained by Canada in analytical and bureaucratic efficiency (due to fewer SCC values at play) is lost to the risk of using SCC values that may not reflect the full picture and the resulting decisions based on such unduly limited information. It is plausible that generating and presenting additional information in the Canadian context may result in different regulatory decisions or at least different regulatory standards in the future. Put another way, without more detailed information, the spectrum of alternatives under consideration is much more narrow and related regulatory decision-making is of poorer quality.

Finally, at a more procedural level, these differences raise concerns around transparency on two fronts. First, the fact that Canada has decided to selectively

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192. *See* Hahn & Ritz, *supra* note 10.

use only some of the U.S. Working Group's SCC values is suspect, particularly given that it is taking place in a field that is already criticized for tenuous judgment calls and misguided assumptions. This concern is also heightened given that Canada's rationale for this practice is extremely thin. Second, less information overall means less transparency about the basis of Canada's regulatory decisions in general. By providing the public and policy-makers the equivalent of only a quarter of the information provided by the United States, the spectrum of different economic valuations of regulatory costs and benefits is much more narrow, making it more difficult to understand what decisions are being made and why.

Potential improvements flowing from this observation are relatively plain to see. The Canadian Working Group and relevant Ministries need to re-examine and better explain any selectivity exercised with respect to only partially importing outputs of the U.S. Working Group. In doing so, those involved in Canadian regulatory impact analyses ought to err on the side of providing more information rather than less. To give some structure and traction to these suggestions for improvement, the Canadian federal government might consider issuing a supplemental Cabinet Directive specific to SCC (perhaps following an external review of SCC practices) clearly setting out how to treat SCC in regulatory impact analyses.

CONCLUSION

As Canada and the United States move to implement respective Nationally Determined Contributions under the Paris Agreement,[193] federal governments in both countries continue to heavily rely on regulatory action to achieve emission reductions.[194] Cost-benefit analysis is fundamental to this approach in both countries. However, scrutiny of the use of SCC as a measure of environmental benefits in cost-benefit analysis reveals fresh evidence that supports long-standing concerns regarding susceptibility to bias, manipulation, uncertainty, and moral judgment. This Article has focused on Canadian and the United States' use of SCC to shed light on SCC estimates and practices on both sides of the border.

The picture that emerges is one of significant similarities, largely owing to the United States leading most of the substantive work, with Canada taking on a free-rider role as it follows along and adopts the U.S. work as a starting point. Though Canada has made what it characterizes as several "minor adjustments" to U.S. work, a closer examination reveals these to be relatively major. The clearest

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193. *See* CANADA, INTENDED NATIONALLY DETERMINED CONTRIBUTION SUBMISSION TO THE UNFCCC, *supra* note 4; UNITED STATES OF AMERICA, INTENDED NATIONALLY DETERMINED CONTRIBUTION SUBMISSION, *supra* note 4.

194. *See* CANADA, INTENDED NATIONALLY DETERMINED CONTRIBUTION SUBMISSION TO THE UNFCCC, *supra* note 4; UNITED STATES OF AMERICA, INTENDED NATIONALLY DETERMINED CONTRIBUTION SUBMISSION, *supra* note 4 (setting out specific regulatory measures as the primary federal tools for emission reductions).

difference stems from Canada's decision to use only a single discount rate and only two different SCC values, compared to the U.S. practice of three discount rates and four different SCC values. This is particularly significant because discount rate has more bearing on SCC estimates than any other single modeling input. Overall, Canada's selective use of U.S. SCC work results in significantly less information in CBAs included in RIAS for GHG emission reduction regulations. In some cases, this selectivity has also resulted in different SCC values. Curiously, the specific regulatory analyses examined in this Article show that these different practices have led to one set of regulations where specific Canada-U.S. regulatory standards are identical (in the case of light-duty vehicle emissions) and one set where thresholds are entirely different (for new coal-fired power plants).

Taken together, findings that emerge from this analysis, especially those attributable to Canada's practices, trace back to broader critiques shared by SCC and CBA. In particular, the selectivity demonstrated by Canada could be viewed as an instance of bias and manipulation that some commentators have warned about with respect to SCC and CBA. Similarly, Canada's practice of providing less information to decision-makers than the United States may serve to confirm fears about inadequate transparency in both the development of SCC estimates and the use of those values. Additionally, Canada's use of single discount rate for SCC and a single rate for the broader CBA, compared to the use of three and two by the United States respectively, is a case-in-point for those who have cautioned about the significant impact this variable can have and the associated need to expand beyond a single value. Finally, both countries' significant reliance on SCC in CBA despite their clear acknowledgement of fundamental limitations with the SCC arguably supports the views that SCC and CBA give false impressions of certainty and that less weight should be accorded to these values given the fallible nature of the methodologies.

Notwithstanding the evidence that feeds existing critiques, for those who believe that SCC and CBA are worthy pursuits,[195] be it due to a lack of alternatives or otherwise, the analysis in this Article does give cause for optimism. It is clear on both sides of the border that governments are working to improve both the SCC values themselves (such as the modeling) and the uses of those values in regulatory decision-making. The United States is once again out ahead with the reports from the GAO and the NASEM, but Canada's recent technical update, and the commitment to further work stated therein, signals that further improvement is forthcoming. On a related note, scholarly attention to SCC continues to grow, uncovering shortcomings and providing a basis that may

195. Indeed, the U.S. Court of Appeals for the Seventh Circuit released a decision on August 08, 2016 upholding the Department of Energy's use of SCC in its regulatory analysis for energy efficiency standards. Zero Zone, Inc. v. U.S. Dept. of Energy, 832 F.3d 654 (7th Cir. 2016).

drive further improvements.[196] Likewise, scientific and economic analyses that inform assumptions underpinning SCC modeling inputs continue to improve.[197] All of these developments are very much in line with past and current thinking that, while SCC and CBA are imperfect tools, they are ones that can and should be refined and improved, but nonetheless cautiously applied in the meantime.

As the evolution of SCC and CBA continues to unfold, the comparison of Canadian and U.S. approaches will serve as an opportunity to better understand practices on both sides of the border and beyond. This Article has taken initial steps on that path, but more inquiry is necessary if SCC and CBA are to improve to a point where they become robust, reliable bases for the deep carbon emission reductions necessary to avoid irreversible, catastrophic, and unjust climate impacts.

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196. *See, e.g.*, Rowell, *supra* note 10.
197. *See* NAT'L ACADS. OF SCIS., ENG'G & MED., *supra* note 42.