ACCOUNTING FOR CLIMATE IMPACTS IN DECISIONMAKING

BY

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Every significant decision made by government agencies, and many made by private organizations, impacts climate change. Ignoring those impacts is increasingly unacceptable. But how to account for a decision's impact on the climate is far from clear. This article seeks to answer that question in the context of the greenhouse gas (GHG) emissions that will likely result from a proposed action and begins with a detailed description of the environmental impact assessment (EIA) process. EIA is crucial to understanding the likely consequences of a proposed action, including the climate-related consequences. EIA also serves as the primary vehicle for estimating GHG emissions and assessing the social cost associated with those emissions. While EIA is most commonly used by government decision makers, tools like EIA work equally well, and are at least as useful in evaluating private actions and their climate impacts.

The article then considers how the environmental assessment should address the difficult questions associated with quantifying GHG emissions. To what extent, for example, should indirect emissions count, and how should decision makers calculate them? Once decision makers quantify GHG emissions, they must quantify their cost to society. The social cost of carbon or, more specifically, the "social cost of greenhouse gases" (SC-GHG), is an increasingly popular tool that provides an estimate of that cost and helps ensure that cost receives fair consideration when an agency is choosing among available options.

Finally, the article considers the growing movement towards corporate social responsibility as reflected in the push for investment firms and corporations to adopt environment, social, and

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governance (ESG) policies. While ESG standards are currently lacking clear definition, and while the idea that corporations should follow ESG policies is controversial within some conservative circles, the movement towards ESG policies in the private sector offers an excellent opportunity to focus organizations on their responsibility to account for the climate impacts associated with every important decision that they make.

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I. INTRODUCTION

Virtually every significant decision that governments make imposes climate-related impacts, including GHG emissions. This is equally true of most important decisions made by private organizations. Sometimes these decisions result in direct emissions, such as proposing a new coal plant or scheduling the clearing of a rain forest. Direct GHG emissions may also occur in more obscure ways, as when a new dam floods carbon-absorbing vegetation, causing that vegetation to decompose and release methane into the atmosphere.[1]

Beyond these examples of direct GHG emissions, most important actions also cause a wide range of indirect emissions. These might include, for example, emissions that result from an organization's energy consumption or the purchase and use of goods in production processes. Indirect emissions might also result from such things as work-related employee travel, waste disposal, or emissions from vehicles used by contractors.[2]

EIA is a well-established tool for identifying and addressing the environmental impacts associated with significant government decisions. But identifying and assessing the climate impacts that may result from government decisions has proved challenging and controversial. Scientists have designed tools to assist government agencies in addressing these issues, most notably by establishing methods for quantifying GHG emissions and by designing protocols to quantify the social cost of carbon. But applying these tools to real-life situations raises difficult questions, including, for example, whether denying a permit to develop fossil fuels might simply lead to a similar level of fossil fuel development in another location.[3]

In addition to government actions, private parties increasingly must confront the climate impacts associated with their own choices because of government mandates, environmental, social, and governance (ESG) polices, or investor or shareholder demands.

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[1] Sonya Angelica Diehn, *The Environmental Impact of Mega-dams*, DW (June 25, 2020), https://perma.cc/G8W3-V923.

[2] *See* THE GREENHOUSE GAS PROTOCOL, A CORPORATE ACCOUNTING AND REPORTING STANDARD 26 (rev. ed. 2004), https://perma.cc/92BU-ZPCC.

[3] *See, e.g.*, High Country Conservation Advocs. v. U.S. Forest Serv., 52 F. Supp. 3d 1174, 1197–98 (D. Colo. 2014) (discussing other cases where courts rejected agency justification for failing to analyze future impacts of coal combustion related to mining operations); *see also*, Michael Burger & Jessica Wentz, *Evaluating the Effects of Fossil Fuel Supply on Greenhouse Gas Emissions and Climate Change under NEPA*, 44 WM. & MARY. ENV'T. L. & POL'Y REV. 423, 490–97 (2020) (discussing courts' findings that agencies cannot ignore unsupported assumptions to ignore downstream GHG emissions).

How well government and private actors account for the climate impacts of their choices will become more important as nation states strive to meet their "nationally determined contribution" (NDC) commitments under the Paris Agreement[4] to the U.N. Framework Convention on Climate Change (UNFCCC).[5] Accurate accounting of a nation's progress towards their NDC is essential for ensuring the success of this Paris Agreement program.[6]

This article offers a road map for how government agencies and private actors can better account for the climate impacts associated with individual programs, actions, or projects, beginning with a general discussion of the EIA process and focusing particularly on how EIA works under the U.S. National Environmental Policy Act (NEPA).[7] While the Act is not without its problems, as the oldest and most fully developed EIA mandate, NEPA provides the best standard against which to measure similar laws. The article then discusses the most effective ways to address climate change in the course of EIA.

Initially, an impact assessment must employ a reliable means for calculating direct and indirect GHG emissions that will likely result from a proposed action. Once quantified, a decisionmaker must account for the cost these emissions impose on our society. As described below, the growing acceptance of sophisticated tools for identifying the social cost of adding a ton of carbon into the atmosphere allows decision makers to at least approximate those costs and thus account for them in their decisions.

Finally, the article considers how private sector decisions not subject to a formal EIA process can use the same or similar tools to minimize their climate-related impacts and appropriately account for emissions. Here, the growing pressure on organizations to adopt and adhere to environmental, social, and governance (ESG) policies is increasing and expected to play an important role. At the present time, the nebulous nature and scope of ESG policies allows organizations to claim adherence to ESG without making meaningful commitments.[8] The

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[4] Paris Agreement to the United Nations Framework Convention on Climate Change, Dec. 12, 2015, T.I.A.S. No. 16-1104.

[5] The treaty requires each Party to "prepare, communicate and maintain successive nationally determined contributions [(NDCs)] that it intends to achieve," and also requires that "[p]arties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions." *Id.* art. 4, ¶ 2.

[6] *See NDC Accounting Rules*, NDC PARTNERSHIP, https://perma.cc/F2TJ-CVGQ (last visited Sep. 5, 2023) (tool for GHG accounting); CHRISTINA HOOD & CARLY SOO, CLIMATE CHANGE EXPERT GROUP PAPER NO. 2017.5: ACCOUNTING FOR MITIGATION TARGETS IN NATIONALLY DETERMINED CONTRIBUTIONS UNDER THE PARIS AGREEMENT (Oct. 2017), https://perma.cc/G7UU-AFA8 (explaining how accounting allows parties to track their own progress, understand other parties' progress, and assess collective progress).

[7] National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321–4370h (2018).

[8] Cristian Angeloni, *Why a Lack of Definition for ESG is Problematic*, INTERNATIONAL ADVISER (Aug. 14, 2019), https://perma.cc/45U7-8KLT ("The financial services industry and bodies have yet to come to a consensus on what makes an ESG product and what the

article offers recommendations for formalizing ESG policies to ensure they are meaningful, transparent, and effectively implemented.

II. THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

A. Background

President Nixon signed the U.S. National Environmental Policy Act (NEPA) into law on January 1, 1970.[9] The Act notably requires federal government agencies to prepare an environmental impact statement (EIS) for all "major [f]ederal actions significantly affecting the quality of the human environment."[10] An important feature of NEPA is the longstanding requirement that the government agency responsible for the decision prepare the EIS, rather than delegating that task to the project proponent.[11] In 2020, the Trump administration promulgated rules authorizing agencies to direct an applicant to prepare environmental documents, including an EIS, subject only to the requirement that the agency retain responsibility for the "accuracy, scope, and content of environmental documents prepared . . . by an applicant . . . ."[12] This is arguably contrary to the specific requirement in the statute that "the responsible official" prepare the EIS.[13] Indeed, the prior rules, which had been in place since 1978, viewed applicant preparation of an EIS as a conflict of interest, and the Biden administration will likely restore the policy set forth under the 1978 rules.[14]

Whether the deciding agency or project proponent should prepare the EIA is a critical matter, especially because the scope of alternatives considered in an applicant-prepared EIA tends to be exceedingly narrow, focusing only on those options the applicant is prepared to carry out.[15] Yet the United States is somewhat unique in historically insisting that the "action agency" prepare any required EIS before deciding whether to authorize the proposed action. Many other countries have adopted laws otherwise parallel to NEPA but that routinely allow

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acronym stands for altogether, leaving scope for misunderstandings and different interpretations.").

9 NEPA, 42 U.S.C. § 4321 (2018).

10 *Id.* § 4332(2)(C) (2018).

11 *See* 40 C.F.R. §§ 1502.1, 1502.4 (2022) (outlining agencies' responsibilities under NEPA).

12 *Id.* § 1506.5(a) (2022) (internal cross-reference omitted).

13 NEPA, 42 U.S.C. § 4332(2)(C) (2018).

14 *Compare* 40 C.F.R. § 1506.5(b) (2021) (Trump rule), *with* 40 C.F.R. § 1506.5(c) (2020) (pre-Trump rule).

15 *Compare* Natural Res. Def. Council v. Morton, 458 F.2d 827, 828, 838 (D.C. Cir. 1972) (requiring a discussion of all reasonable alternatives, including those outside the scope of the agency's responsibilities), *with* Citizens Against Burlington, Inc. v. Busey, 938 F.2d 190, 196 (D.C. Cir. 1991) (suggesting that the alternatives analysis should be limited to those options that meet the private applicant's goals).

project proponents to prepare the environmental analysis for the decision maker.[16] As described in more detail below, this inevitably leads to a conflict of interest whereby the proponent skews the analysis in favor of their desired outcome, whether or not that outcome is environmentally preferable to another alternative. This approach also effectively denies the decisionmaker a clear picture of other, less environmentally harmful options that might be both reasonable and available, even if the project proponent likely would not prefer or even perform those alternatives.[17] So, as described more fully below, the proponent of a new combined-cycle natural gas power plant is unlikely to give serious consideration to alternative energy sources, including, perhaps, renewables.[18] This is true despite the fact that, according to the Energy Information Administration, the levelized cost of electricity from PV solar is less than for combined-cycle gas plants and about the same as for onshore wind, even before accounting for the social cost of carbon associated with a gas plant.[19] Notwithstanding this longstanding federal policy, an amendment to NEPA, adopted in conjunction with the Fiscal Responsibility Act of 2023 allows "a project sponsor … to prepare an environmental assessment or an environmental impact statement under the supervision of the agency" and subject to any procedures that the lead agency might establish.[20] It remains to be seen whether this provision can be implemented to avoid the obvious conflicts of interest that it could create, especially as it concerns the alternatives analysis required by NEPA.

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[16] *See, e.g.*, *Planning and Development Act 2007* (Cth) S 216 (Austl.); *Steps in EIA process*, SRI LANKA CENTRAL ENVIRONMENTAL AUTHORITY, https://perma.cc/MC46-B6QU (Aug. 2013); Federated States of Micronesia, Environmental Impact Assessment Regulations Pt. 2.1 (1989) (Micr.); The Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations (1997) SUPPLEMENT TO THE GOVERNMENT GAZETTE (REGULATIONS) §§ 1–2 (Zam.); MINISTRY OF THE ENV'T, ENVIRONMENTAL IMPACT ASSESSMENT IN JAPAN 4 (2012), https://perma.cc/PZW7-G57P; CENTER FOR INT'L ENV'T LAW, A COMPARISON OF SIX ENVIRONMENTAL IMPACT ASSESSMENT REGIMES 9, https://https://perma.cc/E4WX-9JXP; *see also* ENV'T LAW ALL. WORLDWIDE, GUIDEBOOK FOR EVALUATING MINING PROJECT EIAS 20 (2010), https://perma.cc/UG55-2GM4, for a brief critique of proponent prepared EIAs ("Depending on the EIA system, responsibility for preparing an EIA will be assigned to one of two parties: (1) the government agency or ministry, or (2) the project proponent.").

[17] *See* Mark Squillace, *An American Perspective on Environmental Impact Assessment in Australia*, 20 COLUM. J. ENV'T L. 43, 81 (1995) (examining environmental assessments in Australia, including the lack of consideration of alternatives for a project in assessments prepared by project proponents).

[18] *Discussed infra* Part II.C.

[19] U.S. ENERGY INFO. ADMIN., LEVELIZED COSTS OF NEW GENERATION RESOURCES IN THE ANNUAL ENERGY OUTLOOK 2022 4–5 (2022), https://perma.cc/PPH2-GHG3.

[20] *See* Fiscal Responsibility Act, § 107(f); 42 U.S.C. § 4336a(f) (2018).

B. NEPA's Global Influence

NEPA has had a powerful influence on countries and organizations all over the world. Many countries, as well as many international organizations, have adopted EIA requirements, although the specific requirements vary considerably.[21] The European Union (EU), for example, has had an EIA Directive in place since 1985, although, like many other countries, the EU tasks project proponents with preparing an EIA.[22] Although the EU requires consideration of alternatives, the Directive cabins that requirement by limiting the applicant's obligation to "a description of reasonable alternatives studied by the developer which are relevant to that project."[23] This language appears to allow a project proponent to effectively avoid any meaningful alternatives analysis by simply not studying reasonable alternatives or otherwise deciding that they are not relevant to the proposed project. This is a serious flaw in the EIA process as set forth in the EU Directive for two reasons. First, because the project proponent will naturally prefer the project that it wants to build, whether or not better alternatives might be available, there is a direct conflict of interest. Secondly, and relatedly, the project proponent's failure to fairly consider other, possibly better alternatives denies the decision maker and the public information about other such alternatives.

Another EU Directive on EIA, 2011/92/EU, promotes public participation in the EIA process, allowing the public an opportunity to offer comments about alternatives that can meet the objective of the proposal at a lower environmental or fiscal cost.[24] But this asks too much of the public, which should be able to rely on their government to identify and spell out other alternatives that might better serve the public interest.

The International Court of Justice (ICJ) has also weighed in on the importance of EIA in the transboundary context by making EIA a feature of customary international law. For example, in a dispute between Argentina and Uruguay over water pollution from a pulp mill in Argentina, the ICJ held that "it may now be considered a requirement under general international law to undertake an EIA where there is a risk that the proposed industrial activity may have a significant adverse impact in a transboundary context."[25]

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[21] *See* U.S. Council on Env't Quality, *International Environmental Impact Assessment*, NAT'L ENV'T POL'Y ACT, https://perma.cc/97CB-GN32 (last visited Aug. 27, 2023) (documenting EIA agencies and offices for other countries). The acronym "EIA" is used more commonly than "EIS" when describing the requirements in the international context. *See id.*

[22] *See* Council Directive 85/337/EEC, 1985 O.J. (L 175) 40. See the current directive, promulgated in 2014: Council Directive 2014/52/EU, 2014 O.J. (L 124) 1.

[23] *See* Council Directive 2014/52/EU, 2014 O.J. (L 124) 1, ¶ 31.

[24] *See* Council Directive 2011/92/EU, 2011 O.J. (L 26) 1, ¶¶ 16–21.

[25] Pulp Mills on the Uruguay River (Arg. v. Uru.), Judgment, 2010 I.C.J. 14, ¶ 204 (Apr. 20).

C. The EIS Process Under NEPA

NEPA established a new agency, the Council on Environmental Quality (CEQ), which was subsequently granted the authority to promulgate regulations to flesh out the law.[26] Under the CEQ rules, the key parts of the EIS are: 1) a statement of the purpose and need for the proposed action; 2) an analysis of reasonable alternatives to the proposed action; 3) a description of the affected environment; and 4) a discussion of the environmental consequences of the proposed action and all reasonable alternatives.[27] Preceding the preparation of an EIS is a "scoping" process, whereby the agency determines, with public input, the scope of the issues to be addressed and significant issues relating to the proposal.[28] Public participation is a critical part of the assessment process.[29] In addition to providing input during scoping, the public may comment on a draft assessment and may arrange for meetings with government officials.[30] These officials might also schedule public hearings where they can share their views of the proposal and gain a better understanding of the public's views of the issues, the alternatives, and any potential problems with the proposal.[31]

Despite its modest title, the purpose and need statement has a critical role to play in determining the scope of an EIS and the alternatives analysis that follows.[32] For example, if the government is reviewing a proposal to build a new combined-cycle natural gas power plant, and the proponent describes the project's purpose as generating electricity from a gas plant, then generating electricity with renewable energy would appear to be outside the scope of the analysis, even if renewable energy might satisfy the purpose and need for additional electric power generation at a lower fiscal and environmental cost.[33]

The 1978 CEQ rules simply provided that the EIS "shall briefly specify the underlying purpose and need to which the agency is

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[26] Exec. Order No. 11991, 3 C.F.R. § 123 (1978) (Order "Relating the Protection and Enhancement of Environmental Quality"); NEPA, 42 U.S.C. § 4342 (2018) (establishing the Council on Environmental Quality).

[27] *See* 40 C.F.R. § 1502.10 (2022) (outlining the recommended format for an EIS). These rules require that EISs meet a few other administrative requirements, such as a "list of preparers." *Id.*

[28] *Id.* § 1501.7.

[29] LINDA LUTHER, CONG. RSCH. SERV. RL33152, THE NATIONAL ENVIRONMENTAL POLICY ACT: BACKGROUND AND IMPLEMENTATION 1–2 (2008).

[30] *Id.* at 10; 40 C.F.R. § 1503.1(a)(2)(v).

[31] 40 C.F.R. §§ 1503.1, 1506.6 (2022).

[32] *Id.* § 1502.13.

[33] In 2020, shortly before the end of the Trump Administration, the CEQ promulgated new rules that sought to limit the purpose and need statement to meeting "the goals of the applicant." 40 C.F.R. § 1502.13 (2021). The Biden Administration revised the Trump rules to reverse this narrow interpretation of the law in 2022, 40 C.F.R. § 1502.13 (2022), and at the time of this writing, is considering additional clarifying but non-substantive changes. National Environmental Policy Act Implementing Regulations Revisions Phase 2, 88 Fed. Reg. 49924, 49977 (proposed Jul. 31, 2023) (to be codified at 40 C.F.R. pts. 1500–1508).

responding in proposing the alternatives including the proposed action."[34] The Trump administration revised those rules, only requiring the agency to describe the "applicant's goals and the agency's statutory authority."[35] As suggested above, such a crabbed interpretation of the law could lead to an alternatives analysis focusing solely on modest permutations of the proponent's proposed gas plant. Subsequently, however, the Biden administration restored the original rule, avoiding undue focus on the applicant's goals in describing the purpose and need for a proposed action.[36]

Historically, the CEQ treated the alternatives analysis as "the heart of the environmental impact statement."[37] The alternatives analysis was supposed to "present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decision maker and the public."[38] As contemplated by the 1978 CEQ rules, the alternatives analysis resembles a complex matrix, with the various alternatives under consideration on one axis and the expected environmental impacts, environmental consequences, and the costs and benefits of each of the alternatives on the other axis. If done well, such a matrix should help the decision maker and the public engage in the comparative analysis contemplated by the rules.

In the context of climate change, the consideration of all reasonable alternatives to a proposed action is particularly important because the project proponent rarely absorbs the often substantial external costs associated with GHG emissions.[39] So, as CEQ has recognized, the identification and analysis of reasonable alternatives that reduce GHG emissions provides the decisionmaker with critical information for reaching a good decision.[40]

The Trump rules significantly watered down the alternatives analysis requirement in the 1978 CEQ rules but at the time of this

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[34] 40 C.F.R. § 1502.13 (2020).

[35] Update to the Regulations Implementing the Procedural Provisions of the National Environmental Policy Act, 85 Fed. Reg. 43304, 43365 (July 16, 2020) (to be codified at 40 C.F.R. pts. 1500–1508, 1515–1518).

[36] National Environmental Policy Act Implementing Regulations Revisions, 87 Fed. Reg. 23453, 23458 (Apr. 20, 2022) (to be codified at 40 C.F.R. § 1502.13).

[37] 40 C.F.R. § 1502.14 (2020).

[38] *Id.*

[39] National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change, 88 Fed. Reg. 1196, 1201 (Jan. 9, 2023).

[40] *See id.* at 1203–1204. CEQ acknowledges that "[n]either NEPA, the CEQ Regulations, or this guidance require the decision maker to select the alternative with the lowest net GHG emissions or climate costs or the greatest net climate benefits." *Id.* at 1204. Nonetheless, the Council insists that "in line with the urgency of the climate crisis, agencies should use the information provided through the NEPA process to help inform decisions that align with climate change commitments and goals." *Id.*

writing, the Biden administration had proposed new rules that largely restore the language from the 1978 rules.[41]

The description of the affected environment and the discussion of the environmental consequences of the proposed action and reasonable alternatives are obvious components of any serious assessment of environmental impacts. However, limiting the number, diversity, and scope of the alternatives considered to those minor variations of the original proposal submitted by the project proponent unduly cabins the description of the environment and the discussion of consequences.

D. Public Participation

Among the most important features of the EIA process is the opportunity for the public to engage with the decisionmaker. Typically, action agencies will publish a draft EIA and allow for public comment.[42] Government decision makers may schedule meetings with the public and hold hearings on the proposals.[43] Controversial projects in the United States can generate tens of thousands of public comments, and agencies generally must respond to significant comments or risk having a court declare a decision arbitrary and capricious and thus unlawful.[44] One of the most celebrated cases occurred in 2000 when the Clinton administration issued a draft EIS on a proposal to end virtually all logging, roadbuilding, and mineral development on more than 58 million acres of undeveloped national forest lands.[45] The proposal generated over two million comments and led to more than 600 public hearings.[46] The Clinton administration adopted the final "Roadless Rule" largely as proposed in January 2001, just before President Clinton left office.[47]

Whether or not the EIA process and public participation lead to better decisions is a matter of some debate.[48] In the 1978 rules, CEQ reminded decision makers that "NEPA's purpose is not to generate paperwork – even excellent paperwork – but to foster excellent action."[49] To be sure, EIAs often take too long to produce, cost too much to

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41 *Compare* 40 C.F.R. § 1502.14 (2022) *with* National Environmental Policy Act Implementing Regulations Revisions Phase 2, 88 Fed. Reg. 49977 (July 31, 2023) (to be codified at 40 C.F.R. § 1502.14).

42 LUTHER, *supra* note 29 at 26.

43 *Id.* at 20.

44 *See* Perez v. Mortgage Bankers Ass'n, 575 U.S. 92, 96, 106 (2015) ("An agency must consider and respond to significant comments received during the period for public comment.").

45 Special Areas; Roadless Area Conservation, 65 Fed. Reg. 30276 (May 10, 2000).

46 Larry Edwards, Short Summary of the Roadless Rule's Long History, Greenpeace (Mar. 2011) (work in progress).

47 *See* Special Areas; Roadless Area Conservation, 36 C.F.R. § 294 (2001).

48 Andreea Nita et al., *Researchers' Perspective on the Main Strengths and Weaknesses of Environmental Impact Assessment (EIA) Procedures*, ENV'T IMPACT ASSESSMENT REV., Jan. 2022, No. 106690, at 4.

49 40 C.F.R. § 1500.1(c) (2020).

prepare, and fail to engage the public in any meaningful way.[50] But these failures are frequently the result of poor training of government employees charged with implementing NEPA and a less than fulsome government commitment to the process.[51] Agencies can resolve these problems if they commit to fixing them.[52] And even accepting that the process is imperfect, proposals tend to evolve for the better over the course of studying them.[53] For this reason, EIA should be credited with promoting better decisions, even if the ultimate impact is difficult to measure.

E. EIA and Climate Change

Not surprisingly, as the EIA process has played out over the past two decades, the need to address a proposed action's potential impact on climate change has come to the fore. Among the issues EIA drafters have had to confront are: 1) whether and how to address the cumulative, climate-related effects of past, present, and reasonably foreseeable future actions; 2) how to quantify GHG emissions that might result from a proposed action; and 3) how to measure and account for the social cost of GHGs in the decisionmaking process.[54]

In the United States, courts have weighed in on these issues with increasing frequency, providing some guidance on how agencies might structure their actions to avoid having courts reject their decisions.[55]

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[50] Piet deWitt & Carole A. deWitt, *How Long Does it Take to Prepare an Environmental Impact Statement?*, 10 ENV'T PRAC. 164, 172 (2008); MARK C. RUTZICK, A LONG AND WINDING ROAD: HOW THE NATIONAL ENVIRONMENTAL POLICY ACT HAS BECOME THE MOST EXPENSIVE AND LEAST EFFECTIVE ENVIRONMENTAL LAW IN THE HISTORY OF THE UNITED STATES, AND HOW TO FIX IT 14 (2018); Stewart Lockie, *SIA in Review: Setting the Agenda for Impact Assessment in the 21st Century*, 19 IMPACT ASSESSMENT & PROJECT APPRAISAL 277, 282 (2001).

[51] *See* John C. Ruple et al., *Evidence-Based Recommendations for Improving National Environmental Policy Act Implementation*, 47 COLUM. J. ENV'T L. 273, 310 (2022) (observing that NEPA faces challenges "that grow from an under-resourced agency struggling to adapt to a rapidly evolving mission").

[52] In 2015, President Obama signed the Fixing America's Surface Transportation (FAST) Act, which establishes some useful strategies for streamlining the decisionmaking process and reducing delays associated with NEPA and other federal permitting requirements. 42 U.S.C. § 4370m (2018). Among these, for example, is the establishment of a strict permitting timetable, which can be modified only under limited circumstances. *Id.* The law also sets up an online permitting dashboard that tracks the progress toward making a decision on project proposals. *See* PERMITTING DASHBOARD, https://perma.cc/8KZM-U94U (last visited Sept. 1, 2023). While the law focuses on transportation infrastructure, agencies have used FAST for a wide range of infrastructure projects, including water resources projects and renewable energy projects.

[53] *See generally NEPA Success Stories: Celebrating 40 Years of Transparency and Open Government*, ENVTL. LAW INST. (Aug. 2010), https://www.eli.org/sites/default/files/eli-pubs/d20-03.pdf.

[54] National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change, 88 Fed. Reg. 1196, 1212 (Jan. 9, 2023).

[55] *See, e.g.*, Barnes v. U.S. Dept. of Transp., 655 F.3d 1124, 1139 (9th Cir. 2011) (holding that discussions of greenhouse gases in an environmental analysis can be done in per-

Government agencies have also developed policies and rules on how agencies can most effectively address the climate implications of their proposed actions.[56] Much of the remainder of this article addresses issues involving the quantification and accounting for GHG emissions. Nonetheless, understanding the proper role of cumulative effects in the decisionmaking process is necessary to provide context for addressing the GHG emissions of a proposed project. Moreover, conflicting CEQ rules have emerged recently. For that reason, it merits a brief discussion before turning to the quantification and accounting issues noted above.

F. EIA and Cumulative Effects

The 1978 CEQ rules defined the "scope" of an agency action subject to NEPA to include "[c]umulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement."[57] Those rules also defined "cumulative impact" to mean—

> [T]he impact on the environment which results from the incremental impact when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time.[58]

CEQ also defined "scope" to include impacts that are direct, indirect, or cumulative.[59] The Trump administration repealed this definition entirely and narrowed the scope of "effects" that could be considered in a NEPA document.[60] The Biden administration, however, reversed those decisions.[61] The new rules now define "effects or impacts" to include all

centages and averaged across the nation or the globe); Lands Council v. Powell, 395 F.3d 1019, 1032 (9th Cir. 2005) (requiring that any analysis or modeling done under NEPA review must have adequate, upfront disclosure of any shortcomings in the relevant variables and data); WildEarth Guardians v. Zinke, 368 F. Supp. 3d 41, 67 (D.D.C. 2019) ("[BLM] could reasonably foresee and forecast the impacts of oil and gas drilling across the leased parcels as a whole . . . . '[A]n agency must engage in "reasonable forecasting and speculation," with *reasonable* being the operative word.'" (quoting Sierra Club v. U.S. Dep't of Energy, 867 F.3d 189, 198 (D.C. Cir. 2017))).

[56] *See, e.g.*, Leslie Brandt & Courtney Schultz, *NEPA—Introduction to Incorporating Climate Change*, U.S. FOREST SERV. (June 2016), https://perma.cc/U6GT-8CXH.

[57] 40 C.F.R. § 1508.25(a)(2) (2020).

[58] *Id.* § 1508.7.

[59] *Id.* § 1508.25(c).

[60] Update to the Regulations Implementing the Procedural Provisions of the National Environmental Policy Act, 85 Fed. Reg. 43304, 43375 (July 16, 2020) (to be codified at 40 C.F.R. pts. 1500–1508, 1515–1518) (definition of "effects"); 40 C.F.R. § 1508.1(g) (2021).

[61] National Environmental Policy Act Implementing Regulations Revisions, 87 Fed. Reg. 23453, 23469 (Apr. 20, 2022) (to be codified at 40 C.F.R. pts. 1502, 1507, 1508); 40 C.F.R. § 1508.1(g) (2022).

direct, indirect, and cumulative effects, and they expressly restore the specific language defining "cumulative impact" from the 1978 rules.[62]

Obviously, climate change is a global phenomenon and GHG emissions contribute to the problem wherever they occur.[63] Thus, they offer a textbook example for considering cumulative effects. The challenge, however, is to accurately quantify those emissions resulting from particular activities and then to attribute a cost to each unit of emissions resulting from those activities. The remainder of this article largely focuses on meeting that challenge.

III. CEQ GUIDANCE ON QUANTIFYING AND ACCOUNTING FOR GREENHOUSE GAS ("GHG") EMISSIONS

In recognition of the difficulty and importance of quantifying and accounting for GHG emissions, the CEQ published guidance for agencies in preparing documents required by NEPA.[64] In essence, the new guidance recommends agencies follow three steps:

> (1) Quantify the reasonably foreseeable GHG emissions (including direct and indirect emissions) of a proposed action, the no action alternative, and any reasonable alternatives. . . .
>
> (2) Disclose and provide context for the GHG emissions and climate impacts associated with a proposed action and alternatives, including by . . . monetizing climate damages using estimates of the SC–GHG, placing emissions in the context of relevant climate action goals and commitments, and providing common equivalents. . . .
>
> (3) Analyze reasonable alternatives, including those that would reduce GHG emissions relative to baseline conditions, and identify available mitigation measures to avoid, minimize, or compensate for climate effects.[65]

Importantly, the CEQ Guidance specifically asks agencies to "monetiz[e] climate damages using estimates of the SC–GHG . . ." for all proposed actions.[66] This stands in contrast to some courts' interpretations of the scope of the Interagency Working Group's (IWG) SC-GHG estimates as applying only to regulatory actions.[67]

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62 40 C.F.R. § 1508.1(g) (2022).

63 *See IPCC Press Release: Climate Change Widespread, Rapid, and Intensifying*, INTERGOV'TL PANEL ON CLIMATE CHANGE (Aug. 9, 2021), https://perma.cc/CSG6-YQKC.

64 National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change, 88 Fed. Reg. 1196 (Jan. 9, 2023).

65 *Id.* at 1200–01.

66 *Id.* at 1201.

67 *See, e.g.*, 350 Montana v. Haaland, 50 F.4th 1254, 1272 (9th Cir. 2022) (analyzing the agency's use of carbon accounting methodologies). The court found that, because NEPA does not require a cost-benefit analysis and because IWG developed its figures for rule-making and not project-level decisions, the use of the SCC protocol was not required. *Id.* The court also noted that the Trump administration had abandoned the IWG process

Also important is CEQ's recognition that agencies must address GHG emissions when analyzing reasonable alternatives, including mitigation measures available for each of those alternatives.[68] This is critical information for making a decision that accounts for the climate-related consequences of that decision. Strategies for quantifying these GHG emissions and fairly accounting for them are the subject of the following two sections of the article.

IV. QUANTIFYING GREENHOUSE GAS EMISSIONS

A. An Introduction to Quantification of GHGs

Before one can determine the impact of a proposed action on global climate change, one must determine the extent to which the action will contribute to GHG emissions. Quantifying GHG emissions is no simple task. Some emissions may be direct, as where a facility burns fossil fuels. Others may be indirect but closely tied to the operation of a facility, such as the facility's use of electricity. Still others may be indirect but more remote from the operation of the facility, as with products purchased from third parties for use in the production of goods at the facility.

The Climate Registry (TCR) is a non-profit organization that provides services and tools to help organizations quantify and reduce their GHG emissions.[69] TCR designs and operates voluntary GHG reporting programs and assists member organizations in measuring, reporting, and verifying their carbon emissions to manage and reduce them.[70] The Carbon Footprint Registry, developed by TCR, provides a nexus between business, government, and nongovernmental organizations to share policy information and exchange best practices for GHG emission reductions.[71] TCR's General Reporting Protocol (GRP) Version 3.0 outlines GHG accounting policies and calculation methods that can assist organizations in reporting their carbon footprint.[72] To be considered a complete GHG accounting, an organization's inventory

when the agency was considering the proposed expanded coal mine at issue. *Id.* at 1271. Nonetheless, the court conceded that the agency "must use some methodology that satisfies NEPA and the APA." *Id.* at 1272. But see Diné Citizens Against Ruining Our Env't v. Haaland, 59 F.4th 1016, 1042 (10th Cir. 2023), where the court held that "if an accurate method exists to determine the effect of the proposed action [i.e., the SC-GHG], BLM must perform that analysis or explain why it has not."

68 88 Fed. Reg. at 1198.

69 *About Us*, THE CLIMATE REGISTRY, https://perma.cc/85R4-X3X9 (last visited Aug. 31, 2023).

70 THE CLIMATE REGISTRY, GENERAL REPORTING PROTOCOL A-1 (2019), https://perma.cc/B32R-YEM8.

71 *Id.* at A-1.

72 *Id.* at A-2.

must include all relevant direct and indirect emissions within the reporting boundary.[73]

The Greenhouse Gas Protocol offers a service similar to the TCR's General Reporting Protocol. The World Resources Institute (WRI) launched the partnership of businesses, non-governmental organizations (NGOs), and governments in 1998 with the mission of developing internationally accepted GHG accounting and reporting standards.[74] Together, The Climate Registry and the Greenhouse Gas Protocol provide useful information regarding GHG quantification and reporting. Much of the remaining discussion in this section relies on the TCR's GRP and the GHG Protocol, as well as other research on how best to quantify GHGs.

B. Direct vs. Indirect Emissions

Direct emissions are emissions from sources owned or controlled by the organization, sometimes described as emissions from sources within the organization's "fence line."[75] Indirect emissions, on the other hand, are emissions that are the consequence of the organization's activities but occur at sources owned or controlled by an external organization.[76] For example, a local manufacturing facility's indirect emissions can include emissions from the combined-cycle natural gas plant providing their electricity.[77] Likewise, when a factory buys parts from a third-party manufacturer, the emissions generated in the production of those parts are indirect emissions.

C. The Three Scopes

To differentiate between direct and indirect emission sources and improve transparency, the TCR's General Reporting Protocol GRP,[78] the WRI's Greenhouse Gas Protocol,[79] as well as the U.S. EPA[80] all adhere to the same nomenclature by identifying three distinct emission

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[73] *Id.* at B-3. The TCR's GRP gives organizations flexibility in defining their own "reporting boundary." *Id.* at B-2. The GRP requires, however, that "[o]rganizations . . . publicly define and disclose their own inventory reporting boundary using the following parameters . . . : GHGs; GHG Sources; Reporting Period; and Geography/business units." *Id.*

[74] THE GREENHOUSE GAS PROTOCOL, *supra* note 2, at 2.

[75] *Id.* at 27; *See* THE CLIMATE REGISTRY, *supra* note 70, at B-5 ("Direct GHG emissions are emissions from sources within the organizational boundary.").

[76] THE GREENHOUSE GAS PROTOCOL, *supra* note 2, at 27.

[77] THE CLIMATE REGISTRY, *supra* note 70, at B-5.

[78] *Id.* at B-5–6.

[79] THE GREENHOUSE GAS PROTOCOL, *supra* note 2, at 27.

[80] *Scope 1 and Scope 2 Inventory Guidance*, U.S. ENV'T PROT. AGENCY, https://perma.cc/RXF5-7M47 (Aug. 21, 2023).

"Scopes" (Scopes 1, 2, and 3). This has helped to regularize the GHG accounting and reporting process.[81]

Scope 1 emissions are direct GHG emissions from sources owned, operated, or used by the organization.[82] Examples of Scope 1 emissions include emissions from combustion in boilers and furnaces and vehicles used at the organization's facilities.[83] Scope 1 emissions might also include "fugitive emissions" that result from activities carried out by the organization. For example, an oil and gas operator who drills oil and gas wells, builds and maintains pipelines and storage facilities, or operates natural gas compressor stations, would report leakage of fugitive methane as Scope 1 emissions.[84]

Scope 2 emissions are those that result from the generation of electricity that is purchased or consumed by the organization, or other energy sources to generate heat and steam or cool an organization's facilities.[85] Scope 2 emissions physically occur at the facility generating the electricity but the organization should count them as indirect emissions.[86] The GHG Protocol provides guidance on how to avoid double-counting of emissions by both the generator and the consumer.[87] Moreover, as the TCR's General Reporting Protocol notes, "dual reporting does not constitute double counting because the organizations report the emissions associated with the electricity production and its consumption in different scopes (Scope 1 for the power provider and Scope 2 for the manufacturing organization)."[88]

Scope 3 emissions encompass all other indirect emissions not covered by Scope 1 or Scope 2.[89] Scope 3 emissions might include, for example, emissions that are a consequence of activities that are not owned or controlled by the organization benefitting from the activities.[90] Examples of Scope 3 activities include emissions from employee travel and from a contractor's vehicle use, emissions resulting from the production and distribution of goods or materials used by an organization, and emissions from outsourced activities.[91]

Two other categories of emissions warrant a brief mention here. First, some parties advocate for considering avoided emissions as Scope 4 emissions.[92] These generally result from products designed to save

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81 THE CLIMATE REGISTRY, *supra* note 70, at B-4.

82 THE GREENHOUSE GAS PROTOCOL, *supra* note 2, at 27.

83 *Id.*

84 Alisha Giglio, *What Are Fugitive Emissions and Why Are They Important?*, SINAI TECHNOLOGIES (May 31, 2022), https://perma.cc/DB78-U7PM.

85 THE GREENHOUSE GAS PROTOCOL, *supra* note 2, at 43.

86 *Id.* at 27.

87 *Id.* at 39–40.

88 THE CLIMATE REGISTRY, *supra* note 70, at B-6.

89 *Id.*

90 THE GREENHOUSE GAS PROTOCOL, *supra* note 2, at 41.

91 *Id.* at 26.

92 Jennifer L., *Factoring in Scope 4 Emissions*, CARBON CREDITS (Sept. 12, 2022), https://perma.cc/747B-HEDY.

energy or reduce GHG emissions.[93] Thus far, however, no one has developed a standard method to account for these savings.[94] The other category concerns biogenic emissions that originate from natural sources, such as vegetation that decomposes in soils.[95] Biogenic emissions are considered carbon neutral and should not affect a facility's net GHG footprint.[96] Nonetheless, the GHG Protocol recommends reporting biogenic emissions for the sake of transparency.[97]

The federal government has committed to modeling the effort to identify and reduce GHG emissions. Under Executive Order 14057, President Biden asked "the Federal Government to lead by example in order to achieve a carbon pollution-free electricity sector by 2035 and net-zero emissions economy-wide by no later than 2050."[98] The Order specifically requires that "[e]ach agency shall reduce its scope 1, 2, and 3 GHG emissions, as defined by the Federal Greenhouse Gas Accounting and Reporting Guidance, by setting and meeting targets for fiscal year 2030 measured from a fiscal year 2008 baseline."[99] To help federal agencies comply with the Executive Order, CEQ has issued guidance on compliance strategies.[100]

D. Quantification Methods

TCR's 2019 General Reporting Protocol identifies two main GHG emissions quantification methods.[101] Generally, quantifications are completed either through direct measurement or a calculation method.[102] The proper quantification method for a particular undertaking depends on the information available for each source.

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93 *Id.*

94 *See* ANDREW HOWARD ET AL., A FRAMEWORK FOR AVOIDED EMISSIONS ANALYSIS 7 (2021), https://perma.cc/EX7T-PEE6 (recognizing the failure of current methods to properly account for Scope 4 emissions and proposing a novel framework to measure avoided emissions).

95 *See, e.g.*, *Decomposing leaves are surprising source of greenhouse gases*, NATIONAL SCIENCE FOUNDATION (June 5, 2017), https://perma.cc/N3Q4-N9HF (discussing nitrous oxide emissions from decomposing leaves).

96 *Biogenic Emissions*, SUSTAINABILITY INDICATOR MANAGEMENT & ANALYSIS PLATFORM, https://perma.cc/A238-Z8QQ (last visited Aug. 28, 2023).

97 *Id.*

98 Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability, Exec. Order No. 14057, 86 Fed. Reg. 70935 (Dec. 13, 2021).

99 *Id.* at 70936.

100 COUNCIL ON ENV'T QUALITY, IMPLEMENTING INSTRUCTIONS FOR EXECUTIVE ORDER 14057: CATALYZING CLEAN ENERGY INDUSTRIES AND JOBS THROUGH FEDERAL SUSTAINABILITY (2022), https://perma.cc/3GK4-9H35.

101 THE CLIMATE REGISTRY, *supra* note 70, at C-1. A Council of Jurisdictions that includes representatives from diverse U.S. states and Canadian provinces and territories advises TCR. *Governance*, THE CLIMATE REGISTRY, https://perma.cc/UEU4-NDTL (last visited Sept. 9, 2023).

102 THE CLIMATE REGISTRY, *supra* note 70, at C-1.

1. Direct Measurement with Continuous and Predictive Emissions Monitoring

Systems that monitor the concentration of GHGs and output flow rate may measure emissions directly.[103] Direct measurement of CO2 emissions is available at facilities that use Continuous Emissions Monitoring Systems (CEMS).[104] CEMS monitor GHG concentration and flow rates from facilities such as power plants by periodically sampling exhaust.[105] As described by EPA, a CEMS provides a constant record of emission rates using a pollutant analyzer measurements and a conversion equation, graph, or computer program to produce results in units of the applicable emission limitation or standard.[106] The system employs a probe to extract a small sample of flue gas, which is then pumped into the CEMS.[107] EPA has adopted detailed rules to guide entities using CEMS to monitor their emissions.[108]

An alternative to CEMS, the Predictive Emissions Monitoring System (PEMS) is a software-based system using a facility's existing process data to predict emissions with the aid of statistical methods and machine learning.[109] PEMS can accurately predict emissions while saving significant costs over CEMS.[110]

2. Calculation Methods

Calculation methods are the most common approach to quantifying GHG emissions, however.[111] Similar to, but less sophisticated than PEMS, this approach uses activity data and emissions factors to estimate GHG emissions.[112] According to The Climate Registry, parties using the calculation method to determine GHG emissions should follow six steps:

1. Determine annual consumption of each combusted fuel or annual energy consumption;

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103 *Id.* at C-2.

104 *Id.*

105 *Id.* at C-4–5.

106 *EMC: Continuous Emission Monitoring Systems*, U.S. ENV'T PROT. AGENCY, https://perma.cc/HJA8-8XYL (last updated Aug. 31, 2023).

107 Blake Ericson, *Continuous Emission Monitoring Systems (CEMS): What Are They and Why Do They Matter?*, MONTROSE ENV'T (July 16, 2021), https://perma.cc/B63A-7Q8L.

108 *See* 40 C.F.R. § 75.1 (2021).

109 Olha Zhydik, *Predictive Emissions Monitoring System: Elevating Emission Analytics with Machine Learning*, ELEKS (Aug. 15, 2022), https://perma.cc/NS33-RQER.

110 Sharifuddin M. Zain & Kien Kek Chua, *Development of a Neural Network Predictive Emission Monitoring System for Flue Gas Measurement*, *in* 2011 IEEE 7TH INTERNATIONAL COLLOQUIUM ON SIGNAL PROCESSING AND ITS APPLICATIONS 314, 314 (Mohd Nasir Taib et al. eds., 2011).

111 THE CLIMATE REGISTRY, *supra* note 70, at C-2.

112 *Id.*

2. Determine the [carbon dioxide] emission factor for each fuel or unit of energy consumption;
3. Determine the [methane and nitrous oxide] emission factors for each fuel or unit of energy consumption;
4. Calculate the [carbon dioxide] emissions by multiplying the emission factor by annual fuel or energy consumption;
5. Calculate the [methane and nitrous oxide] emissions by multiplying emissions factors by annual fuel or energy consumption; and,
6. Convert [methane and nitrous oxide] emissions to [carbon dioxide equivalent].[113]

An alternate way to calculate reliable emission data is with fuel use data. Most facilities have access to information on the carbon content of their fuel through default carbon coefficients or through more accurate periodic fuel sampling.[114] Many larger companies will calculate Scope 1 GHG emissions by identifying purchased quantities of commercial fuels and then using published emission factors for those fuels.[115] Scope 2 GHG emissions are generally calculated from metered electricity consumption and published emission factors.[116] On the other hand, firms will primarily use activity data such as fuel use and published or third-party emissions factors to calculate Scope 3 GHG emissions.[117] EPA has published detailed technical guidance on calculating emissions from those falling outside the three scopes, such as biogenic emissions.[118]

V. THE SOCIAL COST OF GREENHOUSE GAS EMISSIONS

Average global temperatures have risen dramatically over the past forty years, leading to an increase in the scope and intensity of floods, fire, drought, storms, and sea level rise.[119] These disasters impose significant costs on society. By one estimate, the United States alone has faced damages totaling $750 billion addressing weather and climate-related disasters during the five-year period that ended in

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113 *Id.* (internal citations omitted).

114 THE GREENHOUSE GAS PROTOCOL, *supra* note 2, at 42.

115 *Id.*

116 *Id.*

117 *Id.*

118 *See, e.g.*, RTI INT'L, GREENHOUSE GAS EMISSIONS ESTIMATION METHODOLOGIES FOR BIOGENIC EMISSIONS FROM SELECTED SOURCE CATEGORIES: SOLID WASTE DISPOSAL WASTEWATER TREATMENT ETHANOL FERMENTATION 3–4 (2010), https://perma.cc/475K-BGYD (providing methodology to EPA for estimating methane and carbon dioxide emissions from wastewater and sludge treatment plants).

119 *See* Rebecca Lindsey & Luann Dahlman, *Climate Change: Global Temperature*, NOAA CLIMATE (Jan. 18, 2023) https://perma.cc/82VF-STNJ; Alice C. Hill et al., *A World Overheating*, COUNCIL ON FOREIGN RELS. (Oct. 18, 2021), https://perma.cc/8A6N-DUTL.

2021.[120] Global damages were likely many times that amount. The Intergovernmental Panel on Climate Change's (IPCC's) Sixth Assessment Report predicts, with high confidence, that as global warming increases, global economic damages will increase non-linearly.[121] Thus, any rational decisionmaking process involving a proposed action that might exacerbate the climate crisis must surely take these costs into account. EIA offers the obvious vehicle for doing so. Fortuitously, scientists have designed a relatively simple tool for estimating the external costs of climate change, or what is known as the "social cost of carbon" (SCC), or perhaps more accurately, the "social cost of greenhouse gases" (SC-GHG). Decision makers can use this tool in the course of preparing an EIA or a cost-benefit analysis associated with a proposed action.[122]

A. What is the Social Cost of Greenhouse Gas Emissions?

The SC-GHG is a monetary estimate of the economic cost resulting from emitting various GHGs into the atmosphere.[123] Much of the focus is on the social cost of CO2 emissions because CO2 is the largest source of GHG emissions, but corresponding data is available for calculating the costs to society of emitting additional units of methane (CH4) and nitrous oxide (N2O)[124] as well as other GHGs.[125] To allow for the

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[120] Rachel Ramirez, *'Off the Charts': Weather Disasters Have Cost the US $750 Billion Over Past 5 Years*, CNN (Jan. 10, 2022), https://perma.cc/966Y-SY37.

[121] *See* HANS-O. PÖRTNER ET AL., SUMMARY FOR POLICYMAKERS 14 (2022), https://perma.cc/LA4W-WVUT ("Projected estimates of global aggregate net economic damages generally increase non-linearly with global warming levels (*high confidence*).").

[122] The United Kingdom uses a variation of the SC-GHG, which they describe as the shadow price of carbon (SPC). HM TREASURY, THE GREEN BOOK: CENTRAL GOVERNMENT GUIDANCE ON APPRAISAL AND EVALUATION 58, 130 (2022), https://perma.cc/LEL8-MS2R. The SPC "is based on the SC[-GHG] . . . but can be adjusted to reflect . . . estimates of the [marginal cost of abatement]," i.e., the cost of reducing GHG emissions rather than looking only at the damages they cause. RICHARD PRICE ET AL., UK DEP'T FOR ENV'T, FOOD & RURAL AFFS., THE SOCIAL COST OF CARBON AND THE SHADOW PRICE OF CARBON: WHAT ARE THEY AND HOW TO USE THEM IN ECONOMIC APPRAISAL IN THE UK 1, 3 (2007), https://perma.cc/RZT4-5L66.

[123] By convention, the social cost of carbon is intended to reflect the damages to society from an incremental increase in carbon dioxide rather than carbon emissions. Carbon consists of one carbon atom weighing 12 atomic mass units, while CO2 consists of one carbon atom weighing 12 atomic mass units and two oxygen atoms weighing 16 atomic mass units each, for a total weight of 44 atomic mass units; thus, one ton of carbon equals 3.67 tons of CO2. Joe Romm, *The Biggest Source of Mistakes: C vs. CO_2*, THINK PROGRESS (Mar. 25, 2008), https://perma.cc/R4SG-6SPG.

[124] Kevin Rennert et al., *The Social Cost of Carbon: Advances in Long-Term Probabilistic Projections of Population, GDP, Emissions, and Discount Rates*, in BROOKINGS PAPERS ON ECONOMIC ACTIVITY 223, 224 (2021), https://perma.cc/J7AQ-ATHK.

[125] *See GHGRP Emissions by GHG*, U.S. ENV'T PROT. AGENCY, https://perma.cc/7RAS-TSHM (Oct. 17, 2022) (noting direct emissions by various greenhouse gasses). The U.S. EPA, for example, requires emissions data on hydrofluorocarbon gases (HCFC-22), perfluorocarbon gases (CF4), and sulfur hexafluoride (SF6). *Greenhouse Gas Reporting Pro-*

aggregation of the costs associated with these different compounds, they are all typically expressed in terms of tCO2e, or per "ton of carbon dioxide equivalent."[126]

By calculating the SC-GHG of the proposed action, and of the various reasonable alternatives, the decision maker can readily see which alternatives impose the least cost on society in terms of their climate impacts. Decision makers can then consider this information alongside other costs and benefits of a particular project and possible alternatives to that project, allowing them to properly account for GHG emission and make the best decision in terms of overall costs and benefits.

As the societal costs of global GHG emissions continue to swell, fair consideration of those costs could easily impact the decision maker's choice. Unfortunately, those responsible for projects that emit GHGs, whether directly or indirectly, have not historically had to pay for these costs.[127] If not fully accounted for, these "externalities" can lead to decisions that make little macroeconomic sense.[128] Moreover, the accuracy of SC-GHG estimates can fairly be called into question, although, as a recent proposal from EPA suggests, the estimates are almost certainly too low rather than too high.[129]

Perhaps the best way to address this problem would be to impose a project fee equivalent to the SC-GHG.[130] This would allow market forces to address the problem of external costs that result in uneconomical decisions. Alternatively, monetizing these external costs and requiring the decision maker to fully account for these costs in their decisions

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gram (GHGRP), U.S. ENV'T PROT. AGENCY, https://perma.cc/JD46-TAXC (Aug. 30, 2022) (listing HCFC-22, CF4, and SF6 in GHGRP in EPA's 2022 data set under the program).

126 *See Overview of Greenhouse Gases*, U.S. ENV'T PROT. AGENCY, https://perma.cc/GYL8-A2D2 (Aug. 25, 2023) (noting that emissions are "often measured in carbon dioxide (CO2) equivalent" and total United States emissions as measured in tons of carbon dioxide equivalent). EPA provides a calculator on the agency's website that allows for simple conversion of energy and emissions data into the CO2 equivalent. *Greenhouse Gas Equivalencies Calculator*, U.S. ENV'T PROT. AGENCY, https://perma.cc/7EU4-AYQ6 (last updated July 2023).

127 INST. FOR POL'Y INTEGRITY, N.Y.U. SCH. OF L., SOCIAL COSTS OF GREENHOUSE GASES 1, (2017), https://perma.cc/S95R-WBUZ.

128 *See* ILIANA PAUL ET AL., THE SOCIAL COST OF GREENHOUSE GASES AND STATE POLICY 2 (2017), https://perma.cc/PR8J-QGQB (discussing "severe adverse" consequences of "externalities," or "damages from emitting greenhouse gasses . . . not reflected in the price of fossil fuels").

129 U.S. ENV'T PROT. AGENCY, EPA EXTERNAL REVIEW DRAFT OF REPORT ON THE SOCIAL COST OF GREENHOUSE GASES: ESTIMATES INCORPORATING RECENT SCIENTIFIC ADVANCES 2, 4 (2022) [hereinafter EPA REPORT ON SC-GHG], https://perma.cc/GGE2-JQAG; *see also*, Nicholas Stern & Joseph E. Stiglitz, *Getting the Social Cost of Carbon Right*, RMI (Feb. 23, 2021), https://perma.cc/773P-BNJP (discussing "externalities"—or the "damages from emitting greenhouse gases [that] are not reflected in the price of fossil fuels").

130 The World Bank maintains a "carbon pricing dashboard" that describes the various mechanisms governments can use to capture these external costs, such as a carbon tax. *Carbon Pricing Dashboard*, WORLD BANK, https://perma.cc/P96R-W39Y (last visited Sept. 4, 2023).

should still lead to better decisions, even if the responsible party is not required to pay for these costs.

B. Estimating the Social Cost of Greenhouse Gas Emissions in the United States

American courts have recognized with growing frequency that government agencies must use a tool like the SC-GHG to analyze the climate impacts of proposed actions in the context of preparing the EISs required by NEPA.[131] While the SC-GHG has been used most prominently in conjunction with the EIS/EIA process, consideration of the social cost of GHG emissions can be equally useful in other decisionmaking contexts, such as electricity ratemaking, land use planning, establishing royalty rates or emissions caps, and setting a carbon price.[132]

1. The Interagency Working Group

President Obama launched the most prominent effort to estimate the SC-GHG in 2009. That year, the Obama administration created the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).[133] The IWG, which was a response to the Ninth Circuit Court of Appeals decision in *Center for Biological Diversity v. National Highway Traffic and Safety Administration*,[134] consists of members from the Council of Economic Advisers, the Office of Management and Budget, the EPA, the Departments of Agriculture, Commerce, Interior, Energy, Transportation, and Treasury, the CEQ, the National Economic Council, the Office of Energy and Climate Change, and the Office of Science and Technology Policy.[135] The IWG has focused primarily on CO2, but has committed to eventually developing estimates for the social cost of methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, pending further research on linkages between non-CO2 emissions and economic impacts.[136] To create the first social cost of carbon (SCC) estimates, the IWG consulted the technical literature in all relevant fields, considered key inputs and assumptions from peer-reviewed climate economic impact models, and weighed public

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131 *See infra* Part III; NEPA, 42 U.S.C. § 4332(2)(C).

132 PAUL ET AL., *supra* note 128, at 1.

133 *Id.* at 13.

134 538 F.3d 1172 (9th Cir. 2008); PAUL ET AL., *supra* note 128, at 13; *see also* U.S. GOV'T ACCOUNTABILITY OFF., GAO-14-663, DEVELOPMENT OF SOCIAL COST OF CARBON ESTIMATES 5 (2014) [hereinafter GAO, DEVELOPMENT OF SOCIAL COST OF CARBON ESTIMATES].

135 INTERAGENCY WORKING GROUP ON SOCIAL COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 2–3 (2010) [hereinafter 2010 TSD], https://perma.cc/ED3W-5AJZ.

136 *Id.* at 12.

comments.[137] The purpose of this extensive process was to create a range of SCC values "using a defensible set of input assumptions that are grounded in the existing literature."[138]

In February 2010, the IWG released the Group's first SCC estimates, along with a Technical Support Document (TSD) that discussed the integrated assessment models (IAMs), their inputs, and the assumptions used to generate the SCC estimates.[139] The IWG settled on four SCC values to be used in regulatory analyses:[140]

> Three values are based on the average SCC from three [IAMs],[141] at discount rates of 2.5, 3, and 5 percent. The fourth value, which represents the 95th percentile SCC estimate across all three models at a 3 percent discount rate, is included to represent higher-than-expected impacts from temperature change . . . .[142]

This initial TSD established a SCC of $32.8 per ton for the year 2030 at a 3% discount rate in 2007 U.S. dollars.[143] The SCC values were "intended to include (but [are] not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change."[144]

According to the 2010 TSD, the purpose of the SCC estimates was "to allow agencies to incorporate the social benefits of reducing carbon dioxide (CO2) emissions into cost-benefit analyses of regulatory actions that have small, or 'marginal,' impacts on cumulative global emissions."[145] SCC estimates were designed be used in a wide range of

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137 *Id.* at 2–3.

138 *Id.* at 3.

139 PAUL ET AL., *supra* note 128, at 14.

140 2010 TSD, *supra* note 135, at 1.

141 These three models (DICE, PAGE, and FUND) are discussed in detail in the next two sections of the article, *infra* V(B.II–III).

142 2010 TSD, *supra* note 135, at 1.

143 *Id.*

144 *Id.*

145 *Id.* In 1993, President Bill Clinton issued Executive Order 12866 requiring federal agencies, to the extent permitted by law, to "assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." Exec. Order No. 12866, 3 C.F.R. § 638–39 (1993). Thus, the SC-GHG may prove a useful tool for assessing the costs of regulatory actions. While the Executive Order does not apply directly to other agency actions, such as particular projects that must be reviewed in an environmental impact assessment process, courts have sometimes required agencies to address these costs or risk having their decisions deemed arbitrary and capricious. *See, e.g.*, *Diné Citizens Against Ruining Our Env't*, 59 F.4th 1016, 1025, 1042 (10th Cir. 2023) ("[I]f an accurate method exists to determine the effect of the proposed action [i.e., the SC-GHG], BLM must perform that analysis or explain why it has not."); *see also* Vecinos para el Bienestar de la Comunidad Costera v. Fed. Energy Regul. Comm'n, 6 F.4th 1321, 1325 (D.C. Cir. 2021); *High Country Conservation Advocs.*, 52 F. Supp. 3d 1174, 1189–93 (D. Colo. 2014). But see *350 Montana v. Haaland*, 50 F.4th 1254, 1271–72 (9th Cir. 2022), where the court suggested that the SC-GHG was not required for project level decisions, partially because it was designed for cost-benefit

energy and environmental actions, and in preparing EIAs in particular.[146] In this first TSD, the IWG committed to continually updating the SCC estimates to reflect the latest scientific and economic developments in the understanding of climate change impacts.[147]

In 2013, the IWG issued an updated TSD with revised SCC estimates.[148] The 2013 TSD established a SCC of $52.0 per ton for the year 2030 at a 3% discount rate in 2007 U.S. dollars, an increase of $19.2 from the 2010 TSD estimate.[149] The revised estimates used updated versions of the same three IAMs used in the 2010 report.[150] The 2013 TSD reinforced IWG's commitment to update the SCC estimates continually based on the best available science and peer reviewed literature.[151]

In 2014, the U.S. Government Accountability Office (GAO) reviewed the processes used by the IWG in 2010 and 2013 to develop the SCC estimates.[152] The GAO found that the IWG processes sufficiently relied on peer-reviewed academic literature and modeling, were transparent about modeling limitations and uncertainty, and properly incorporated, when relevant, new information from public comments and updated research.[153]

In 2015, the IWG issued another revised TSD.[154] The 2015 TSD established a SCC of $50.0 per ton for the year 2030 at a 3% discount rate in 2007 U.S. dollars, a decrease of $2.0 from the 2013 TSD estimate.[155] The updated SCC values were based on corrections to two of

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analyses prepared for rulemaking proceedings. The court made clear, however, that the agency must use some methodology for assessing the impact of GHG emissions that satisfies NEPA and the APA. *Id.* at 1176. See also *Louisiana v. Biden*, 585 F. Supp. 3d 840, 852, 861, 870 (W.D. La. 2022), which enjoined federal agencies from IWG SC-GHG estimates. However, the Court of Appeals for the Fifth Circuit stayed that decision pending appeal, *Louisiana by & through Landry v. Biden*, No. 22-30087, 2022 WL 866282, at *3 (5th Cir. Mar. 16, 2022), and the U.S. Supreme Court denied an application to vacate the stay. Louisiana v. Biden, 142 S. Ct. 2750 (2022).

146 One study suggests that the SC-GHG should be used in electricity ratemaking and regulation, natural resource valuation and royalty setting, regulatory cost-benefit analysis for climate actions, environmental impact statements, and setting carbon emissions caps or taxes. PAUL ET AL., *supra* note 128, at 8.

147 2010 TSD, *supra* note 135, at 3.

148 INTERAGENCY WORKING GROUP ON SOCIAL COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 1–2 (2013) [hereinafter 2013 TSD], https://perma.cc/CFB7-M96V.

149 *Id.* at 13; 2010 TSD, *supra* note 135, at 1.

150 2013 TSD, *supra* note 148, at 4.

151 *Id.*

152 *See* GAO, DEVELOPMENT OF SOCIAL COST OF CARBON ESTIMATES, *supra* note 134 (Why GAO Did This Study).

153 *Id.* at 8.

154 INTERAGENCY WORKING GROUP ON SOCIAL COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 (2015) [hereinafter 2015 TSD], https://perma.cc/D2ZC-2N84.

155 *Id.* at 3.

the models employed by the IWG in 2013.[156] All other assumptions, inputs, and modeling decisions remained the same as those employed in calculating the 2013 SCC estimates.[157]

In 2015, the IWG asked the National Academies of Sciences, Engineering, and Medicine (NASEM) to review the latest research on modeling the economic aspects of climate change to inform future revisions of the SCC estimates.[158] The IWG made this request in an effort to increase the credibility and support for the Group's SCC estimates and ensure its estimates employed the latest peer-reviewed science.[159]

In January 2016, NASEM's Committee on the SCC issued an interim report in response to the IWG's 2015 request.[160] In that interim report, the Committee recommended against a near-term update to the SCC estimates established in the revised 2015 TSD.[161] Additionally, the report recommended that the IWG enhance how the Group acknowledges and discusses uncertainties in the IAMs and their inputs used to calculate the SCC estimates.[162] To accomplish this, the report suggested including a section titled "Treatment of Uncertainty" that included a discussion of the "various types of uncertainty and how they were handled in estimating the SCC, as well as sources of uncertainty that are not captured in current SCC estimates" in each revised TSD.[163]

Of course, uncertainty is inherent in any analysis of future conditions. With SC-GHG estimates, uncertainty also stems from gaps in the data pertaining to the physical, economic, and behavioral processes linking GHG emissions to human health.[164] Aspects of the natural environment and future human behavior are the sources of this uncertainty.[165] In addition, uncertainty arises from predictions about the future physical impacts that GHG emissions will have on Earth systems,[166] as well as from human responses to climate change.[167] Among the important but unknowable factors that could influence climate predictions are future population growth, human capacity and willingness to adapt, the level of future GHG emissions and economic

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156 *Id.* at 21.

157 *See id.* (noting that 2015 revision included two corrections: running model through 2300 and ensuring estimates were in 2007 dollars).

158 *Id.* at 2.

159 NAT'L ACADS. OF SCIS., ENG'G, AND MED., ASSESSMENT OF APPROACHES TO UPDATING THE SOCIAL COST OF CARBON: PHASE 1 REPORT ON A NEAR-TERM UPDATE 5 (2016).

160 *Id.* at 1.

161 *Id.* at 46.

162 *Id.* at 48.

163 *Id.*

164 2015 TSD, *supra* note 154, at 18.

165 *Id.*

166 *Id.*

167 *See* Brian Beckage et al., *The Earth Has Humans, so Why Don't Our Climate Models?*, 163 CLIMACTIC CHANGE 181, 182 (2020) (noting behavioral responses to climate change that cause uncertainty in modeling).

growth, and how Earth system changes will translate to economic damages.[168]

In August 2016, the IWG issued another revised TSD responding to the January 2016 recommendations from NASEM.[169] The 2016 SCC estimate—of $50.0 per ton for the year 2030 at a 3% discount rate in 2007 U.S. dollars—is identical to the SCC found in the 2015 version of the TSD.[170] The 2016 TSD, however, also included additional information about the uncertainties inherent in the SCC estimates, a new section with a unified discussion of the various sources of uncertainty and how the IWG approached these uncertainties in estimating the SCC values, and new appendices describing in more detail the uncertain parameters in the FUND and PAGE models.[171]

Around the same time the IWG issued the revised 2016 TSD, the Group also issued an Addendum to the 2016 TSD, establishing social cost values for methane (CH4) and nitrous oxide (N2O) emissions.[172] In the 2010 TSD, the IWG stated that, "further research is required to link non-CO2 emissions to economic impacts," and therefore the IWG did not endorse the use of monetized values of non-CO2 emissions in regulatory analyses at that time.[173] However, since the 2010 TSD, new estimates of the social cost of non-CO2 GHG emissions have emerged, and a 2015 study by Marten et al. produced the first published set of estimates for the SC-CH4 and SC-N2O.[174] The social cost estimates produced by the study are consistent with the methodology and modeling assumptions used by the IWG to establish the SC-GHG estimates. The study used the same three IAMs, the same discount rates, and estimated global, as opposed to only domestic, costs associated with the emission of an additional ton of a specified GHG.[175] In the 2016 Addendum, the IWG calculated the social cost of CH4 at $1,600 per ton and the social cost of N2O at $19,000 per ton for the year 2030 at a 3% discount rate in 2007 U.S. dollars.[176] The IWG noted that, although these values are

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168 INTERAGENCY WORKING GROUP ON SOCIAL COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 18 (2016) [hereinafter 2016 TSD], https://perma.cc/RCK4-HB7E.

169 *Compare id*. at 4, *with* 2015 TSD, *supra* note 154, at 3.

170 *Id.* at 4.

171 *Id.* at 18–20 (Appendixes B and C).

172 INTERAGENCY WORKING GROUP ON SOCIAL COST OF CARBON, ADDENDUM TO TECHNICAL SUPPORT DOCUMENT ON SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866: APPLICATION OF THE METHODOLOGY TO ESTIMATE THE SOCIAL COST OF METHANE AND THE SOCIAL COST OF NITROUS OXIDE (2016) [hereinafter 2016 Addendum], https://perma.cc/T24M-W2P9.

173 2010 TSD, *supra* note 135, at 12.

174 A. L. Marten et al., *Incremental CH4 and N2O Mitigation Benefits Consistent with the U.S. Government's SC-CO2 Estimates*, 15 CLIMATE POL'Y 272 (2015); 2016 Addendum, *supra* note 172, at 2–3.

175 *Id.* at 3.

176 *Id.* at 7.

significantly higher than the SCC for the year 2030 at a 3% discount rate, they are likely still underestimated.[177]

The methodology and estimates, which were employed and established in a 2014 study by Alex Marten and others, were incorporated into the Addendum and have been the subject of rigorous peer review and public comment.[178] Additionally, the OMB found that the use of the SC-CH4 and the SC-N2O estimates established by the Marten et al. study and adopted by the IWG to be consistent with OMB's Information Quality Guidelines Bulletin for Peer Review and OMB Circular A-4 requirements.[179] Similar to past TSDs regarding the SCC estimates, the Addendum acknowledged the limitations and uncertainties surrounding the SC-CH4 and the SC-N2O estimates, and committed the IWG to continually updating these estimates to reflect the latest relevant scientific and economic developments.[180]

In January 2017, NASEM issued a final report recommending more substantial long-term improvements to the IWG process for calculating the SCC estimates.[181] The report endorsed the continued near-term use of the existing SCC estimates based on the DICE, FUND, and PAGE models as established in the 2016 TSD.[182] Shortly thereafter, however, in March 2017, President Trump issued Executive Order 13783 disbanding the IWG and withdrawing all IWG documents pertaining to the SCC as no longer representative of governmental policy.[183] The Executive Order required agency heads to review all the actions their agency took that "potentially burden[ed] the development or use of domestically produced energy resources, with particular attention to oil, natural gas, coal, and nuclear energy resources," and to submit a report with specific recommendations for ways their agency could unburden domestic energy production.[184]

EO 13783 required that, when estimating costs and benefits in regulatory analyses, agencies should base their estimates on the best available science and economics.[185] The EO further required agencies to ensure all estimates are consistent with the guidance presented in the OMB Circular A–4 when monetizing the value of changes in GHG emissions resulting from regulations.[186]

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177 *Id.* at 4, 7–8.

178 *Id.* at 3.

179 *Id.*

180 *Id.*

181 NAT'L ACADS. OF SCIS., ENG'G, AND MED., VALUING CLIMATE DAMAGES: UPDATING ESTIMATION OF THE SOCIAL COST OF CARBON DIOXIDE 1–2 (2017).

182 *Id.* at 2, 27.

183 Promoting Energy Independence and Economic Growth, Exec. Order 13,783, 3 C.F.R. § 314 (2017).

184 *Id.*

185 *Id.*

186 *Id.*; *see also* OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, CIRCULAR A-4: REGULATORY ANALYSIS 1 (2003) [hereinafter CIRCULAR A-4] ("This Circular provides the Office of Management and Budget's (OMB's) guidance to Federal agencies on

The Circular A-4 provides general guidance to agencies on how to conduct regulatory analyses of agency rules and regulations, as opposed to the TSDs issued by the IWG which focus specifically on estimating SCC values that can be utilized in a variety of decisionmaking contexts.[187] Unlike the TSDs issued by the IWG, the Circular requires a regulatory impact analysis to focus on the costs and benefits that accrue only to U.S. citizens and residents.[188] According to the Circular, an analysis from the international perspective is optional.[189] The Circular states that, when presenting a regulation's projected future costs and benefits in present-day values, agencies should use discounting.[190] When using discounting, the Circular further recommends agencies calculate estimates at both a 7% and 3% discount rate.[191] The Circular also asserts that, "as a base-case for regulatory analysis," agencies should use "a real discount rate of 7 percent" as a default.[192] Finally, in regards to discounting, the Circular permits agencies to consider using a lower but positive discount rate in addition to the 7% and 3% discount rates when a regulation will have intergenerational costs or benefits.[193] The IWG used this leeway to justify the lower range of discount rates established in the 2010 TSD and used until the Group's dissolution.[194] In an interview with the GAO, OMB staff confirmed that the IWG properly interpreted and implemented their Circular A-4 guidance on discounting in the 2010 TSD.[195]

Before President Trump disbanded the IWG in EO 13783,[196] EPA's National Center for Environmental Economics calculated the SC-GHG estimates for the Group.[197] After President Trump disbanded the IWG and withdrew all IWG documents pertaining to the SC-GHG estimates as no longer representative of governmental policy, EPA once again calculated the SC-GHG, this time in accordance with the EO 13783 and the OMB's 2003 Circular A-4.[198] EPA established a SCC of $8 per ton at a 3% discount rate and $1 per ton at a 7% discount rate for the year 2030 in 2018 U.S. dollars.[199] EPA established a SC-CH4 of $242 per ton

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the development of regulatory analysis as required under . . . a variety of . . . authorities.").

187 CIRCULAR A-4, *supra* note 186, at 1; U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-20-254, SOCIAL COST OF CARBON: IDENTIFYING A FEDERAL ENTITY TO ADDRESS THE NATIONAL ACADEMIES' RECOMMENDATIONS COULD STRENGTHEN REGULATORY ANALYSIS 18 n.47 (2020) [hereinafter GAO, SCC: IDENTIFYING A FEDERAL ENTITY].

188 *Compare* CIRCULAR A-4, *supra* note 186, *with, e.g.*, 2010 TSD, *supra* note 135, at 10.

189 2010 TSD, *supra* note 135, at 10.

190 CIRCULAR A-4, *supra* note 186, at 31–32.

191 *Id.* at 34.

192 *Id.* at 33.

193 *Id.* at 36.

194 2010 TSD, *supra* note 135, at 17–18.

195 GAO, SCC: IDENTIFYING A FEDERAL ENTITY, *supra* note 187, at 20 n.51.

196 *Id.* at 20.

197 *Id.* at 13.

198 *Id.* at 20.

199 *Id.* at 57.

at a 3% discount rate and $85 per ton at a 7% discount rate for the year 2030 in 2018 U.S. dollars.[200] Under the Trump administration, EPA did not establish an official SC-N2O.[201] However, in the agency's 2020 regulatory analysis for the final Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule, the National Highway Traffic and Safety Administration used the SC-GHG approach to estimate a SC-N2O of $2,820 per ton at a 3% discount rate for the analysis's forecast period.[202]

Although EPA used the same IAMs as the IWG to calculate these SC-GHG estimates, the Agency's post-EO 13783 estimates were significantly lower due to two key assumptions. First, the Trump era estimates accounted only for domestic impacts.[203] Second, EPA calculated the estimates using a higher range of discount rates: 3–7% as opposed to the 2.5–5% rates used in the TSDs.[204]

On January 20, 2021, President Biden issued EO 13990, which reinstated the IWG. [205] EO 13990 directed the IWG to issue interim SC-GHG estimates within thirty days for agencies to use when monetizing the value of changes in GHG emissions resulting from regulations and other applicable government actions.[206] The IWG was supposed to issue final SC-GHG estimates no later than January 2022.[207] The Executive Order also directed the Group to make recommendations to the President for additional areas of decisionmaking, budgeting, and procurement by the Executive branch where the SC-GHG estimates should be applied.[208] The IWG was further tasked with reviewing and, as appropriate, revising the SC-GHG estimates so that they were based on the best available science and economics and adequately accounted for climate risk, environmental justice, and intergenerational equity.[209] In particular, the EO 13990 reversed the Trump administration policy of considering only the domestic impacts of GHG emissions.[210] Specifically, the Biden EO required "agencies [to] capture the full costs of greenhouse gas emissions as accurately as possible, including by taking global damages into account."[211]

In carrying out the above directives, the EO urged the IWG to: 1) consider recommendations from the 2017 NASEM final report and other relevant scientific and economic literature; 2) solicit public comment and

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200 *Id.* at 58.

201 *Id.*

202 *Id.*

203 *Id.* at 14.

204 *Id.*

205 Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crises, Exec. Order No. 13990, 86 Fed. Reg. 7037, 7040 (Jan. 20, 2021).

206 *Id.* (requiring separate estimates for carbon, nitrous oxide, and methane.).

207 *Id.*

208 *Id.*

209 *Id.*

210 *Id.*

211 *Id.* ("Doing so facilitates sound decision-making, recognizes the breadth of climate impacts, and supports the international leadership of the United States on climate issues.").

engage with the public and stakeholders; 3) seek the advice of ethics experts; and 4) ensure the SC-GHG estimates adequately reflect the interests of future generations in mitigating the impacts of climate change.[212] More generally, the EO directed all executive departments and agencies to review, and, where appropriate, address and revise all the actions taken by the Executive branch during the Trump administration that did not adequately address the climate crisis or ran counter to the current administration's climate policy goals.[213]

President Biden issued a separate Memorandum on January 20, 2021 titled *Modernizing Regulatory Review* that called on the Director of OMB to "identify ways to modernize and improve the regulatory review process, including through revisions to OMB's Circular A-4, … to … reflect new developments in scientific and economic understanding [and] fully account[] for regulatory benefits that are difficult or impossible to quantify…."[214] Two particular aspects of the current approach under Circular A-4 seem ripe for reform by the Biden administration. Addressed in more detail below, one is the recommended use of discount rates of 3% and 7%, which many economists believe are too high.[215] The other is the Trump administration's decision to narrowly construe Circular A-4's focus to just domestic costs and benefits, even though some international effects—like those that result from climate change—plainly impact U.S. interests.[216] This interpretation might be a misreading of Circular A-4, which, at a minimum, recommends reporting of international effects.[217] Moreover, as the 2017 NASEM report acknowledges, global pollutants like GHGs can have "international implications that impact the United States."[218]

In February 2021, the IWG issued a TSD presenting interim findings and interim SC-GHG estimates, with the intent that they be utilized by agencies when engaging in regulatory analyses and other applicable actions until the IWG issues more comprehensive and updated estimates in 2022.[219] The IWG SC-GHG estimates for the year

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212 *Id.* at 7041.

213 *Id.* at 7037.

214 Memorandum on Modernizing Regulatory Review, 2021 DAILY COMP. PRES. DOC. 63, at 1 (Jan. 20, 2021) (internal citation omitted).

215 *See infra* text accompanying notes 361–71.

216 JASON A. SCHWARTZ, INST. FOR POL'Y INTEGRITY, N.Y.U. SCH. OF L., ENHANCING THE SOCIAL BENEFITS OF REGULATORY REVIEW 19–20 (2020), https://perma.cc/959T-C7HS. The former head of the Institute for Policy Integrity, Richard Revesz, is now the Director of the Office of Information and Regulatory Affairs (OIRA) in OMB and is expected to push through reforms to Circular A-4. *Richard Revesz confirmed as head of the White House OMB's Office of Information and Regulatory Affairs*, NYU LAW (Dec. 29, 2022) https://perma.cc/9CA6-NVT6.

217 CIRCULAR A-4, *supra* note 188, at 15 ("Where you choose to evaluate a regulation that is likely to have effects beyond the borders of the United States, these effects should be reported separately.").

218 NAT'L ACADS. OF SCIS., ENG'G, & MED., *supra* note 181, at 9.

219 INTERAGENCY WORKING GROUP ON SOCIAL COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT

2030 at a 3% discount in 2020 U.S. dollars were as follows: (1) a SC-CO2 of $62 per ton; (2) a SC-CH4 of $2000 per ton; and (3) a SC-N2O of $23,000 per ton.[220] These figures are functionally the same as the SC-GHG estimates used during the Obama administration, after being adjusted for inflation.[221] To calculate the interim estimates, the IWG relied on the same models, inputs, and assumptions used by the previous IWG since 2013.[222] As required by the Biden Executive Order, this includes a return to accounting for global emission impacts in the SC-GHG estimates,[223] as well as a return to using a discount rate range of 2.5-5%.[224] The IWG issued these interim estimates because of "the immediate need to have operational SC-GHG [estimates] for use in regulatory benefit-cost analyses and other applications that [were] developed using a transparent process, peer reviewed methodologies, and the science available at the time of that process."[225] However, the IWG also acknowledged issues with the current methodology employed to calculate the estimates, and committed to incorporating more thoroughly the recommendations from the 2017 NASEM report and other relevant academic literature in the Group's future TSD.[226] The 2021 TSD also states that the IWG will take comments on how to best incorporate the NASEM recommendations and other recent scientific and economic developments into the 2022 TSD.[227]

2. The Models Used by the IWG

Since the first TSD in 2010 and as recently as the 2021 TSD,[228] the IWG has relied on three integrated assessment models (IAMs) to develop the SC-GHG estimates. The Group gives each of the three models, DICE, PAGE, and FUND, equal weight in the calculation of the estimates.[229] First presented in 1990, the DICE (Dynamic Integrated Climate and Economy) model, developed by William Nordhaus, evolved from a series of energy models.[230] The following year, Chris Hope created the PAGE (Policy Analysis of the Greenhouse Effect) model, initially intending for European decision makers to use PAGE in their assessment of the marginal impact of carbon emissions.[231] Designed

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ANALYSIS UNDER EXECUTIVE ORDER 13990, at 3–4 (2021) [hereinafter 2021 TSD], https://perma.cc/MD95-95ZC.

220 *Id.* at 5–6.

221 *Id.* at 5 n.3.

222 *Id.* at 22.

223 *Id.* at 16.

224 *Id.* at 4.

225 *Id.* at 3.

226 *Id.*

227 *Id.*

228 *Id.* at 23 (stating that details on the IAMs and their input parameters used to calculate the 2021 estimates can be found in the 2010 TSD and the 2016 TSD).

229 2010 TSD, *supra* note 135, at 5.

230 *Id.* n.2.

231 *Id.*

initially to study international capital transfers policy, Richard Tol developed the FUND (Climate Framework for Uncertainty, Negotiation, and Distribution) model in the early 1990s, around the same time as Nordhaus and Hope.[232] The three IAMs combine economic growth, climate processes, and feedbacks between the climate and the global economy into a single modeling framework.[233]

To calculate the SC-GHG estimates, the three IAMs "translate emissions into changes in atmospheric greenhouse concentrations, atmospheric concentrations into changes in temperature, and changes in temperature into economic damages."[234] Although each IAM takes a different approach to modeling how incremental increases in GHG emissions result in economic damages,[235] each is run using the same three sets of input parameters: 1) equilibrium climate sensitivity (ECS)[236]; 2) socio-economic (population and GDP) and GHG emissions trajectories; and 3) discount rates.[237]

The DICE model is calibrated to include the impacts (damages) from global warming on the production of market and nonmarket goods and services.[238] The model accounts for impacts on agriculture, coastal areas, sea level rise (SLR),[239] other vulnerable market sectors (based primarily on changes in energy use), human health (based on pollution and climate-related diseases such as malaria and dengue fever), non-market amenities (based on outdoor recreation), and human settlements and ecosystems.[240] The model also accounts for damages stemming from, "low probability, high impact 'catastrophic' climate change."[241] Adaptation is not explicitly represented in the DICE model.[242] However, adaptation is implicitly assumed in many areas of impacts accounted for under the model.[243] For impacts on agriculture, the model assumes that farmers will adapt land use decisions to changing climate conditions.[244]

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232 *Id.*

233 *Id.*

234 *Id.*

235 *Id.*

236 "Equilibrium climate sensitivity" (ECS) "measures the amount of global warming over hundreds of years after a doubling of the atmospheric CO2 concentration. An ECS range of 1.5°C–4.5°C has been consistently supported by climate models over the past 40 years." Jiang Zhu et al., *Assessment of Equilibrium Climate Sensitivity of the Community Earth System Model Version 2 Through Simulation of the Last Glacial Maximum*, GEOPHYSICAL RSCH. LETTERS, Feb. 16, 2021, at 1, https://perma.cc/7JCJ-FCGY.

237 2010 TSD, *supra* note 135, at 6.

238 *Id.*

239 2016 TSD, *supra* note 168, at 7. In 2016, the IWG started using an updated version of the DICE model. *Id.* The updated model includes an explicit representation of economic damages from SLR in addition to the impacts on coastal areas due to SLR, which was included in the earlier version of the DICE model used by the IWG since 2010. *Id.*

240 2010 TSD, *supra* note 135, at 6.

241 *Id.*

242 *Id.*

243 *Id.*

244 *Id.*

For impacts on human health, the model assumes healthcare improvements over time.[245]

The PAGE model calculates impacts from global warming separately for eight geographic regions and divides damages into four categories: economic, noneconomic, catastrophic, and SLR.[246] Unlike the DICE model, the PAGE model treats catastrophic events probabilistically, where the changes of a catastrophic event increase once temperature increases past a certain threshold.[247] Human adaptation is explicitly included in the PAGE model.[248] For damages in the economic category, the model assumes that adaptation will "mitigate all damages up to a temperature increase of 1℃, and for temperature anomalies between 1℃ and 2℃, [adaptation] will reduce damages by 15-30 percent (depending on the region)."[249] For damages in the non-economic category, the model assumes that adaptation will reduce damages by 15% for temperature increases between 0℃ and 2℃.[250] The model assumes that once average global temperatures increase more than 2℃, adaptation will not mitigate any of the impacts of climate change.[251] For damages due to SLR, the model assumes that adaptation will reduce 25–50% of damages (depending on the region) from the first 0.20 to 0.25 meters of SLR but assumes adaptation will be ineffective after SLR exceeds 0.25 meters.[252]

The FUND model is calibrated to consider impacts (damages) to eight market and nonmarket sectors, and impacts to each sector are calculated separately for sixteen geographic regions.[253] The eight sectors include: agriculture, forestry, water, energy (based on heating and cooling demand), SLR (based on the value of land lost and cost of protection),[254] ecosystems, human health (diarrhea, vector-borne diseases, and cardiovascular and respiratory morality), and extreme weather.[255] Adaptation is explicitly accounted for in the agriculture and SLR sectors.[256] Adaptation is included implicitly in other sectors such as

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245 *Id.*

246 2010 TSD, *supra* note 135, at 7. In 2016 the IWG started using an updated version of the PAGE model that included a damage category for SLR. 2016 TSD, *supra* note 158, at 13. In the previous version of the model, the other damages categories subsumed damages from SLR. *Id.*

247 *Id.*

248 2010 TSD, *supra* note 135, at 7.

249 2016 TSD, *supra* note 168, at 14.

250 *Id.* at 15.

251 *Id.* at 14.

252 *Id.* at 15.

253 2010 TSD, *supra* note 135, at 7–8.

254 In 2016 the IWG started using an updated version of the FUND model with updated damage functions for impacts to the following sectors: agriculture, SLR, and energy. 2016 TSD, *supra* note 168, at 7.

255 2010 TSD, *supra* note 135, at 7–8.

256 *Id.* at 8.

energy and human health, where the model assumes that wealthier populations will be less vulnerable to climate impacts.[257]

Recall that each IAM is run using the same three sets of input parameters: 1) equilibrium climate sensitivity (ECS); 2) socio-economic (population and GDP) and GHG emissions trajectories; and 3) discount rates.[258] ECS is defined as, ". . .the long-term increase in the annual global-average surface temperature from a doubling of atmospheric CO2 concentrations relative to pre-industrial levels (or stabilization at a concentration of approximately 550 parts per million (ppm))."[259] To represent the ECS input parameter used in all three IAMs, the IWG uses the Roe and Baker ECS distribution,[260] a probability distribution, calibrated to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR4).[261] The Roe and Baker distribution for the ECS input parameter is "bounded between 0 and 10 with a median of 3°C and a cumulative probability between 2 and 4.5°C of two-thirds."[262]

Socio-economic (population and GDP) trajectories are closely related to global warming damages because wealthier and more populous countries tend to emit more GHGs, and wealthier populations have a higher willingness and capacity to pay to avoid warming impacts.[263] To account for the relationship between socio-economic pathways and climate damages, the IWG decided to model GDP, population, CO2 emissions, and non-CO2 radiative forcing together as socio-economic and emission trajectories that span a range of plausible future scenarios.[264] The IWG relies on the Stanford Energy Modeling Forum exercise (EMF-22)[265] to select five trajectories to be imputed into each IAM.[266] Four of the five trajectories represent potential business-as-usual growth in population, GDP, and CO2 emissions and consider CO2 atmospheric concentrations ranging from 612 to 889 ppm in 2100.[267] The fifth trajectory is more optimistic scenario and represents a lower than business-as-usual growth in population, GDP, and CO2 emissions and assumes CO2 atmospheric concentrations will stabilize at 550 ppm.[268] A key advantage of using the five EMF-22 scenarios is that

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257 *Id.*

258 *Id.* at 6.

259 *Id.* at 12; *see also* Jiang Zhu, et al., *supra* note 236 (further defining Equilibrium Climate Sensitivity).

260 Gerard H. Roe & Marcia B. Baker, *Why is Climate Sensitivity So Unpredictable*?, 318 SCIENCE 629, 629 (2007), https://perma.cc/TAP3-WL7K.

261 2010 TSD, *supra* note 135, at 13.

262 *Id.* at 24.

263 *Id.* at 15.

264 *Id.*

265 John Weyant, *EMF 22: Climate Change Control Scenarios*, STANFORD UNIV., https://perma.cc/4J5V-5QGA (last visited Sept. 14, 2023).

266 2010 TSD, *supra* note 135, at 15.

267 *Id.*

268 *Id.*

GDP, population, and emission trajectories are internally consistent for each scenario.[269]

All three IAMs calculate a stream of future damages in terms of reduced consumption resulting from the emission of an additional ton of CO2. Once the stream of future damages has been determined, it must be discounted to its present value in the year when the additional ton of CO2 was released.[270] To accomplish this discounting, the IWG selected three discount rates—2.5%, 3%, and 5%—to span a plausible range of certainty-equivalent constant discount rates.[271] The three selected discount rates are intended to represent society's marginal rate of substitution between consumption in different time periods.[272] The range of discount rates reflects both uncertainty and different policy judgments and values.[273] The 3% discount rate reflects the consumption rate of interest[274] and is consistent with the U.S. Office of Management and Budget (OMB)'s Circular A-4 guidance.[275] The IWG states that the consumption rate of interest is the correct discounting concept to use when future damages from global warming are estimated in terms of reduced consumption (consumption-equivalent units).[276] The 5% discount rate is included to account for the possibility that damages resulting from the emission of additional units of CO2 are positively correlated with market returns, which would mean that the appropriate discount rate is higher than the consumption rate of interest (3%).[277] The 2.5% discount rate is included to acknowledge the concern that interest rates are highly uncertain over time.[278]

Since its first TSD in 2010, the IWG has endorsed SC-GHG estimates that account for the global costs and benefits, as opposed to domestic costs and benefits that result from reducing U.S. GHG emissions.[279] The IWG justifies this position primarily with two observations. First, even when emitted in the U.S., GHG emissions contribute to damages around the world.[280] If the U.S. wants to meaningfully address the global problem of climate change, the SC-

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269 *Id.*

270 *Id.* at 17.

271 *Id.* at 23.

272 *Id.* at 17.

273 *Id.* at 1, 19–20.

274 James Broughel, *The Social Discount Rate: A Primer for Policymakers*, MERCATUS CTR. (June 30, 2020), https://perma.cc/Z2EK-VGAD ("The consumption rate of interest . . . represents the rate at which a unit of consumption in the present is traded for a unit of consumption in the future.").

275 2010 TSD, *supra* note 135, at 23.

276 *Id.*

277 *Id.* An alternative to the consumption rate of interest approach to discounting is the "opportunity cost of capital" approach. EPA REPORT ON SC-GHG, *supra* note 129, at 113. The EPA has found, however, that this approach can substantially underestimate net benefits. *Id.*

278 2010 TSD, *supra* note 135, at 23.

279 *Id.* at 11.

280 *Id.* at 10.

GHG estimates must account for all the damages resulting from GHG emissions, not just those recognized within its borders.[281] Second, the U.S. cannot solve the problem of climate change alone. Even if the U.S. emitted zero GHGs, other countries would still need to take significant steps towards reducing their GHG emissions if serious damages from global warming are to be avoided.[282] A global solution is needed to address the global problem of climate change, and world leaders—like the U.S.—accounting for the global benefits of reducing domestic emissions could ignite reciprocal actions and policies by other countries.[283]

3. The Limits of the Models

George Box, a British statistician, once famously noted that while "all models are wrong, some are useful."[284] So it is with the models developed to calculate the SC-GHG. While they are far from perfect, they might nonetheless prove useful in estimating the social cost of GHGs.[285] Indeed, it is hard to see how one would calculate the SC-GHG without them. The goal then should be to improve the models so that they are more useful and more accurate, even as they will remain imperfect.

The models that the IWG has used to calculate the SC-GHG have been criticized for a variety of reasons, but perhaps most significantly for failing to consider or fully account for certain damages that result from climate change. In his 2014 paper, *Omitted Damages: What's Missing from the Social Cost of Carbon*, Peter Howard discusses eleven categories of damages that are either not considered by the models or are insufficiently considered.[286] Howard's eleven categories are health, agriculture, oceans, forests, ecosystems, productivity and economic growth, water, transportation, energy, catastrophic impacts and tipping points, and inter- and intra- regional conflict.[287] The deficiencies with

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[281] *Id.*

[282] *Id.* at 10–11.

[283] *Id.* at 11.

[284] James Clear, *All Models Are Wrong, Some Are Useful*, JAMES CLEAR, https://perma.cc/5N25-4DDN (last visited Sept. 14, 2023).

[285] *But see* Robert L. Bradley Jr., *Climate Models: Worse Than Nothing?*, AM. INST. FOR ECON. RSCH. (June 23, 2021), https://perma.cc/F79T-SMWC (arguing that climate models might not only be unhelpful but may even make matters worse by presenting false information).

[286] PETER HOWARD, OMITTED DAMAGES: WHAT'S MISSING FROM THE SOCIAL COST OF CARBON 5 (2014), https://perma.cc/ZYX5-54PM. *Omitted Damages* was published as part of the Cost of Carbon Project, which is a joint project of the Environmental Defense Fund, the Institute for Policy Integrity, and the Natural Resources Defense Council. *Id.* While Howard's paper was published in 2014, the three IAM versions discussed by Howard (DICE 2010, FUND 3.8, and PAGE 09) are the same versions used by the IWG in 2021 to develop its most recent SC-GHG estimates. *See* 2021 TSD, *supra* note 219, at 22. Thus, Howard's analysis is just as relevant today as it was during the Obama administration.

[287] HOWARD, *supra* note 286, at 2–3.

the IAMs in these eleven categories, as described by Howard, are summarized below.

Carbon emissions can adversely impact human health in a variety of ways, including, for example, from: 1) stresses imposed by high and low temperature; 2) an increase in vector-borne and non-vector-borne infectious diseases; 3) deterioration of air and water quality; and 4) increases in the number and intensity of floods and storms.[288] All of these categories can impact an individual's health directly, but they can also impose significant indirect health impacts when, for example, they cause forced migration, political and civil unrest, and increased violence.[289] None of the three IAMs used by the IWG to calculate the SC-GHG address these impacts on health.[290]

The IAMs certainly do consider the climate impacts to agriculture, but they fail to do so comprehensively.[291] For instance, the SC-GHG estimates exclude damages from weeds, pests, and pathogens;[292] food price spikes;[293] and extreme weather events such as fires, droughts, heat waves, and precipitation extremes.[294] Climate change will likely contribute in some way to all of these problems.[295]

As for oceans, the IAMs fail to adequately account for damages to fisheries, terrestrial species (via extinction and forced migration), and coral reefs resulting from ocean acidification, temperature increases, and extreme weather.[296] For climate impacts on fisheries, the DICE model implicitly assumes that damages to fisheries are equal to zero, while the FUND and PAGE models fail to acknowledge damages to fisheries at all.[297] All three IAMs fail to account for the multiple damages resulting from ocean acidification, such as damages to fisheries, biodiversity, ecosystems, and tourism.[298] Damages to fisheries from CO2 emissions will likely be substantial, and these damages will be felt throughout the world.[299] A significant portion of the world's population relies on fisheries and aquaculture as a primary source of

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288 *Id.* at 30 (citing Richard S.J. Tol, *Estimates of the Damage Costs of Climate Change Part 1: Benchmark Estimates*, 21 ENV'T & RES. ECON. 47, 59 (2002)).

289 HOWARD, *supra* note 286, at 30.

290 *Id.*

291 *Id.* at 20 (first citing FRANK ACKERMAN & ELIZABETH A. STANTON, CLIMATE ECONOMICS: THE STATE OF THE ART 8–9 (Stockholm Env't Inst. Ed., 2011); and then citing WILLIAM R. CLINE, THE ECONOMICS OF GLOBAL WARMING 103 (Inst. For Int'l Econ. Ed., 1992)).

292 HOWARD, *supra* note 286, at 20.

293 *Id.* at 31.

294 *Id.* at 20, 41.

295 *Id.* at 20 (citing INTERGOV'TL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY: CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE IPCC, at 273–314, U.N. Sales No. 07.III.D.38 (2007) [hereinafter IPCC, CLIMATE CHANGE 2007]).

296 HOWARD, *supra* note 286, at 18–20.

297 *Id.* at 18–19.

298 *Id.* at 42.

299 *Id.* at 18–19.

food and employment.[300] In developing countries with particular dependence on fishing, these damages will likely be especially severe.[301]

Regarding forests, the IAMs fail to account for climate-related damages to forest ecosystems, such as from pest infestations and pathogens, species invasion and migration, flooding and soil erosion.[302] These ecosystem changes, will likely reduce timber production and increase the magnitude and variability of wildfires.[303] Wildfires in particular are likely to impose significant costs that the IAMs do not account for, such as those related to public health from smoke inhalation, harm to life and property, and fire management.[304]

More generally, the three IAMs either completely ignore or only partially account for damages to ecosystems and ecosystem services. Such damages include loss of biodiversity and habitats as well as species extinction.[305] Biodiversity losses are arguably among the largest of the omitted impacts of climate change,[306] although these damages are difficult to value, in part because of uncertainty surrounding how climate change will impact complex and fragile ecosystems.[307] The loss of certain ecosystems such as beaches, coral reefs, and islands can also impose costs to outdoor recreation and tourism, which are similarly unaccounted for in the IAMs.[308] In addition, the IAMs underestimate or fail to account for damages to ecosystem services, which might include, for example, crop pollination from the loss of pollinators, and flood management and control from loss of wetlands.[309]

The IAMs also ignore many of the climate-related damages to labor productivity and economic growth.[310] Extreme heat and other extreme weather events connected to climate change can disrupt labor productivity and labor supply. Extreme weather impacts workers in a variety of ways, including by damaging their homes, places of work, and other infrastructure, such as roads, powerlines, and facilities, that may be necessary to carry out work.[311]

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300 *Id.* at 19.

301 *Id.*

302 *Id.* at 20.

303 IPCC, CLIMATE CHANGE 2007, *supra* note 295, at 289–90.

304 HOWARD, *supra* note 286, at 20, 30.

305 *Id.* at 29.

306 *Id.* (citing Richard S.J. Tol, *The Economic Effects of Climate Change*, J. ECON. PERSPS., Spring 2009, at 44 [hereinafter Tol, *The Economic Effects of Climate Change*]).

307 HOWARD, *supra* note 286, at 29.

308 *Id.* at 2, 23.

309 *Id.* at 27–28.

310 *Id.* at 3.

311 *Id.* at 23 (first citing Samuel Fankhauser & Richard S. J. Tol, *On Climate Change and Economic Growth*, 27 RES. & ENERGY ECON. 1, 2, 6 (2005); then citing Tol, *The Economic Effects of Climate Change*, *supra* note 306, at 43; and then citing E. J. Moyer et al., *Climate Impacts on Economic Growth as Drivers of Uncertainty in the Social Cost of Carbon* 13, 25 (Ctr. for Robust Decisionmaking on Climate & Energy Pol'y Working Paper, 2013)).

Water supplies are already at risk in certain parts of the world due to drought, pollution, and overexploitation.[312] Climate change places further strains on water supplies, which in turn can compromise energy production, sanitation services, and crop production, and exacerbate land-based problems like surface subsidence and soil erosion.[313] Yet the IAMs fail to consider these and similar impacts.[314]

Climate change will have both positive and negative impacts on transportation.[315] For example, rising temperatures means fewer transportation delays and accidents due to snow and ice.[316] Less snow and ice will also result in less money spent on salting roads and snow plow equipment.[317] Additionally, winter shipping costs could decline as warming temperatures limit ice cover in oceans, rivers, and lakes.[318] However, the negative effects of climate change on transportation and infrastructure are even more substantial.[319] The increasing frequency and variability of extreme weather events such as floods, heavy precipitation events, droughts, and storms will disrupt transportation on roads, railways, and at airports.[320] Heavy precipitation events and floods, especially in coastal communities, will likely inundate roads and other transportation systems.[321] In inland areas, mudslides and landslides will bury roads and other transportation infrastructure.[322] But, again, these impacts are largely ignored by the IAMs.

Climate change will impact energy supplies, in both positive and negative ways.[323] These impacts might be covered with more fulsome consideration of water availability and extreme weather events, which

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312 *See Water—at the Center of the Climate Crisis*, UNITED NATIONS, https://perma.cc/3BJ4-DFJV (last visited Sept. 6, 2023) (discussing impacts to water quality from drought and pollution); Press Release, U.N. Human Rights Office of the High Commissioner, World Must End Overexploitation of Groundwater, Says UN Expert (Mar. 18, 2022), https://perma.cc/GZK4-FCYD (discussing overexploitation of water).

313 HOWARD, *supra* note 286, at 5, 7–8, 20–21, 33, 40, 41 n.119; *see also Groundwater Decline and Depletion*, U.S. GEOLOGICAL SURV. (June 6, 2018), https://perma.cc/74CH-LB38 (excessive groundwater pumping can lead to land subsidence).

314 HOWARD, *supra* note 286, at 2–3, 20–21, 30, 41 n.119.

315 *Id.* at 21–22.

316 *Id.* at 21.

317 *Id.*

318 *Id.*; *see also* Javier Yanes, *Arctic Shipping Routes, the New Suez Canal?*, OPEN MIND BBVA (Jul. 23, 2021), https://perma.cc/K27C-BL48 (discussing the growth of maritime traffic in the arctic in recent years).

319 HOWARD, *supra* note 286, at 22; *see also* Laura Moretti & Giuseppe Loprencipe, *Climate Change and Transport Infrastructures: State of the Art*, SUSTAINABILITY, Feb. 2018, at 1–3, 10 (describing negative impacts of climate change on transportation and infrastructure).

320 HOWARD, *supra* note 286, at 22.

321 *Id.*

322 *Id.*; James H. Diaz, *Global Climate Changes, Natural Disasters, and Travel Health Risks*, 13 J. TRAVEL MED. 361, 370 (2006).

323 *Id.* at 21.

are likely to be negative.[324] But positive impacts might come from the opening of shipping lanes through the Arctic Ocean, which will reduce shipping costs and transportation times.[325]

Finally, for the most part, the IAMs assume each region of the world is independent of all others.[326] Climate change can cause many inter-regional effects by disrupting global markets.[327] This can include decreasing the availability of imported goods, such as agricultural and energy products, and decreasing the demand for exported goods.[328] Climate change will also displace many people from regions impacted by rising seas, floods, and other climate-related weather events. This will in turn result in the forced migration that will strain the resources of countries less susceptible to climate change.[329]

The IAMs' failure to account for catastrophic impacts and tipping points is a major criticism of the models and is discussed in more detail below in the critique of the DICE model. While some of the omissions may play out as benefits and thus reduce the SC-GHG, the vast majority of omissions are likely to impose significant societal costs. The failure to fully account for these matters strongly suggests that the IAMs seriously underestimate the SC-GHG.[330]

C. The DICE Model Critique

Integrated assessment models are complex, and that complexity arguably makes them more vulnerable to criticism. Indeed, the failure of the models to fully address certain types of damages, as discussed in the previous section, is surely related to that complexity and the difficulty of integrating all of the myriad potential damages into the model.

Beyond the omission of certain types of climate-related impacts, other flaws with the models warrant a critical review. This section focuses on the DICE model because its critics have been especially vocal about its potential problems and limitations.[331] So, although this review

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[324] For example, warming water temperatures could increase the cooling costs for thermal power plants, and decreasing water availability could increase hydro costs. HOWARD, *supra* note 286, at 21. Likewise, more frequent and variable extreme weather events could severely disrupt energy supply and transmission. *Id.*

[325] *Id.*

[326] *Id.* at 39.

[327] *E.g.*, *id.* (explaining how global spillover effects could impact the U.S. economy).

[328] *Id.*

[329] *Id.* at 34, 39.

[330] *See* Jody Freeman & Andrew T. Guzman, *Seawalls Are Not Enough: Climate Change and US Interests*, Berkeley Program in Law and Economics (2009) (discussing the challenges posed by climate change and the inadequacy of seawalls as a protective measure); HOWARD, *supra* note 286, at 39 (providing an analysis of coastal protection measures in the context of climate change).

[331] *See, e.g.*, Steve Keen, *Playing DICE with Life on Earth: Nordhaus's Damage Function*, PATREON (May 11, 2019), https://perma.cc/7R8E-MMYC (discussing critiques of Nordhaus's damage function model and its implications for climate change policy); Michael Grubb et al., *Modeling myths: On DICE and Dynamic Realism in Integrated Assess-*

is limited to DICE, it should not be read to suggest that the other IAMs lack for valid critiques.[332] Rather, it is intended to recognize some of DICE's deficiencies and acknowledge that, as noted previously, modeling the SC-GHG remains an imperfect science. While the scientific community periodically reviews and updates the models, and presumably improves them, they nonetheless provide fodder for critics who prefer to reject the use of the SC-GHG as a tool to improve decisionmaking. In this regard, it bears repeating that most of the critiques suggest that the models are underestimating, not overestimating, the SC-GHG. In this way, the SC-GHG that is derived by the IWG from the DICE, FUND, and PACE models can be viewed as the minimum cost associated with adding one ton of CO2 to the environment.[333]

Nordhaus's DICE model has received the most substantial criticism from the global economic and scientific communities. That model has been criticized for: 1) severely underestimating how increases in average global temperatures translate to reductions in global gross domestic product (GDP);[334] 2) failing to account for "discontinuities" that could lead to catastrophic changes in the global phenomena, like the Gulf Stream;[335] 3) failing to account adequately for technological innovation and inertia;[336] and 4) assuming that adaptation will be costless and more effective than it is likely to be.[337]

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ment Models of Climate Change Mitigation, 12 WIREs CLIMATE CHANGE 698, 698 (2020), https://perma.cc/67AQ-MFSL (critiquing "temporal independence," or the assumption that future abatement costs are unaffected by previous abatement costs, concluding that abatement actions taken now will likely reduce their costs in the future); Robert K. Kaufmann, *Assessing the DICE model: Uncertainty Associated With the Emission and Retention of Greenhouse Gases*, 35 CLIMATIC CHANGE 435, 435 (1997), https://perma.cc/J6CX-X86B (stating that the DICE model "contains unsupported assumptions, simple extrapolations, and misspecifications that cause it to understate the rate at which economic activity emits greenhouse gases and the rate at which the atmosphere retains greenhouse gases," thus underestimates the costs of climate change).

332 *See, e.g.*, Nicholas Stern, *Economics: Current Climate Models Are Grossly Misleading*, 530 NATURE 407, 408 (2016), https://perma.cc/R8ZP-4G54 (providing general criticism of IAMs for the lack of inclusion of various tipping points as well as social issues such as mass immigration and conflicts caused by climate change, leading to an underestimate of the cost of climate change).

333 *See* 2021 TSD, *supra* note 219, at 4 ("It is the IWG's judgment that, taken together, these limitations suggest that the range of four interim SC-GHG estimates presented in this TSD likely underestimate societal damages from GHG emissions.").

334 *See, e.g.*, Keen, *supra* note 331 (arguing that the model's estimate of future reduction in GDP based on increasing global temperatures does not pass "the smell test").

335 *Id.*

336 Michael Grubb & Claudia Wieners, *Modeling Myths: On the Need for Dynamic Realism in DICE and other Equilibrium Models of Global Climate Mitigation* § 9 (Inst. For New Econ. Thinking, Working Paper No. 112, 2020), https://perma.cc/AR5T-SUYP.

337 *See* MICHAEL D. MASTRANDREA, CALCULATING THE BENEFITS OF CLIMATE POLICY: EXAMINING THE ASSUMPTIONS OF INTEGRATED ASSESSMENT MODELS 54 (2009), https://perma.cc/G4Y6-TV5R ("[C]urrent treatment of adaptation [in IAMs] may overestimate the capacity of adaptation to offset damages and underestimate adaptation costs.");

Steve Keen, a renowned Australian economist and author, and one DICE's chief critics, argues that DICE severely underestimates how rising global temperatures translate to reductions in global GDP. Keen takes particular issue with Nordhaus' 2017 paper, *Revisiting the Social Cost of Carbon*, in which Nordhaus argued that under the DICE model, global GDP will decrease by only 8.5% if average global temperatures rise by 6°C.[338] While a decrease of 8.5% may seem significant, DICE predicts that it will take 130 years for average global temperatures to increase 6° even if no mitigation efforts are taken.[339] An 8.5% decrease in global GDP spread out over 130 years would therefore amount to an annual decrease in global GDP of less than 0.1%.[340] For Keen, if the relationship between warming and GDP is correct, as assumed by DICE, then climate change does not present a significant threat to the planet and "[w]e should all just sit back and enjoy the extra warmth."[341]

Keen argues that an increase in average global temperatures of 6° will decrease global GDP by far more than 8.5%.[342] He asserts, for example, that a 6° increase in global temperatures will cause the ice sheets in Greenland and the Antarctic to melt away completely, causing all human settlements below 70 meters above sea level to be inundated and its residents forced to relocate and rebuild.[343] Likewise, the extreme heat could make many human settlements close to the Equator, such as those in the Middle East and Northern Africa, unlivable, forcing people in these areas to relocate to survive.[344] Keen contends that between forced human migration, accommodating mass migration by way of city rebuilding or expansion, and all of the other adverse global effects resulting from a 6° rise in temperature, global GDP will decrease by far more than 8.5%.[345]

Keen also takes issue with the DICE model's failure to account for "discontinuities," or the point where the relationship between temperature increases and global GDP breaks down.[346] Keen's concern is that under DICE, no temperature level is assumed to trigger fundamental changes in the earth's climate such that it could effectively cripple the global economy as we know it.[347] Examples of fundamental changes in the earth's climate include the melting of the polar ice caps,

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see also 2021 TSD, *supra* note 219, at 30 (noting the "incomplete treatment of adaptation and technological change" by IAMs).

338 Keen, *supra* note 331 (citing William Nordhaus, *Revisiting the Social Cost of Carbon*, 114 PROCEEDINGS OF THE NAT'L ACAD. OF SCI. 1518, 1519 (2017), https://perma.cc/MD2A-C2UP.

339 *Id.*

340 *Id.*

341 *Id.*

342 *See id.* ("[I]f an economic model returns a prediction like [Nordhaus's], it has to be . . . fill in your favourite expletive here.").

343 *Id.*

344 *Id.*

345 *Id.*

346 *Id.*

347 *Id.*

the collapse of the Gulf Stream, or El Nino becoming a permanent phenomenon.[348] Keen points out that adding a "tipping point" into the DICE model at a 4° increase in global temperatures could help address this problem.[349] Including a tipping point in the DICE damage function would result in predictions of greater reductions in GDP as global temperatures increase, including for temperature increases below the tipping point of 4%.[350]

In their 2020 article, *Modeling Myths of Climate Change*, Michael Grubb and Claudia Wieners also criticize DICE for failing to account for inertia and innovation in its representation of technological advancements and economic transformation.[351] Under DICE, "[t]he abatement cost at time t . . . does not depend at all on abatement beforehand."[352] Therefore, the model assumes "temporal independence," which means the cost of abatement or emission cuts in 2050 will be the same regardless of whether or not we have previously deployed renewable energy infrastructure, built more efficient buildings, implemented electric vehicles on a global scale, or continued to invest in and build fossil fuel infrastructure that now needs to be dismantled.[353] Grubb and Wieners argue that this "temporal independence" is unrealistic because it fails to account for both inertia and innovation.

Inertia clearly exists in our global energy systems and infrastructure where "fast changes are more difficult and more expensive than smoother transitions."[354] Replacing current energy infrastructure built around fossil fuels with clean, renewable grids is cheaper when done over the span of twenty, thirty, or fifty years as opposed to over the course of a single or couple of years.[355] Abatement costs in the aggregate are lower if we gradually replace the oldest, highest polluting, and least efficient fossil fuel infrastructure with clean technology and renewable energy compared to continuing to invest in fossil fuels until we reach a point where abatement needs to occur all at once.[356]

Past abatement efforts not only add to the stock of existing renewable/clean infrastructure, making total abatement efforts cheaper, but also lower the cost of efforts in the present as a result of innovation.[357] The industries surrounding clean energy gain experience and build up supply chains over time, becoming more efficient and cost-effective as more and more renewable energy infrastructure is

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348 *Id.*

349 *See id.* (calling a 4 degree tipping point "reasonable").

350 *Id.*

351 Michael Grubb & Claudia Wieners, *Modeling Myths of Climate Change*, INST. FOR NEW ECON. THINKING (Feb. 10, 2020), https://perma.cc/M222-MDQJ.

352 *Id.*

353 *Id.*

354 *Id.*

355 *Id.*

356 *Id.*

357 *Id.*

installed.[358] Grubb and Wieners conclude that this is a fundamental failure of the DICE model and argue that how models treat innovation and inertia is just as important as their assumptions about climate damages.[359]

Finally, Michael Mastrandrea has criticized DICE for failing to fairly account for the cost of adaptation. Specifically, he argues that "DICE assumes very effective adaptation, and largely ignores adaptation costs."[360] For example, DICE assumes that farmers can and will adjust their land use decisions based on changing climate conditions, thereby minimizing the impacts to agriculture resulting from increasing temperatures.[361] Likewise, for impacts to health, the model assumes that improvements in healthcare will occur over time, thereby presumably minimizing the cost of adapting.[362] Mastrandrea acknowledges that the "[c]osts of resettlement due to inundation of coastal areas from sea level rise are incorporated into damage estimates[,]" but notes that "their magnitude is not clearly reported."[363] In addition, according to a study cited in the 2010 TSD,[364] the model implies "optimistic and costless adaptation" for small impacts to the sectors of forestry, water systems, construction, fisheries, and outdoor recreation.[365]

D. A Critique of the IWG's Use of Discount Rates

"Discount rate" is a term used to reflect the fact that "a dollar in the present is worth more than a dollar in the future because of variables such as inflation and interest rates."[366] Thus, a higher discount rate results in a more significant reduction in future costs and benefits, especially those that occur many years into the future.[367] Put another way, the higher the discount rate, the lower the present value of a future asset.

The discount rates utilized by the IWG to estimate the SC-GHG have received substantial criticism from scientific and economic

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358 *Id.*

359 *Id.*

360 MASTRANDREA, *supra* note 337, at 33.

361 2010 TSD, *supra* note 135, at 6.

362 *Id.*

363 MASTRANDREA, *supra* note 337, at 32–33.

364 WILLIAM NORDHAUS & JOSEPH BOYER, WARMING THE WORLD: ECONOMIC MODELS OF GLOBAL WARMING 77, 79 (2000).

365 2010 TSD, *supra* note 135, at 6–7.

366 Nick Lioudis, *Time Value of Money and the Dollar*, INVESTOPEDIA (July 10, 2022), https://perma.cc/NKR2-FGQB.

367 *See* David Gorton, *A Quick Guide to the Risk-Adjusted Discount Rate*, INVESTOPEDIA (May 19, 2022), https://perma.cc/TB7W-3WDD (giving the following example: "A project requiring a capital outflow of $80,000 will return a cash inflow of $100,000 in three years. A company can elect to fund a different project that will earn 5%, so this rate is used as the discount rate. The present value factor in this situation is $((1 + 5\%)^3)$, or 1.1577. Therefore, the present value of the future cash flow is ($100,000/1.1577), or $86,383.76.").

communities for two particular reasons. First, the central discount rate of 3% was not considered an accurate representation of the consumption rate of interest at the time that it was being used. Second, the use of three constant certainty-equivalent discount rates is not viewed as the best method for capturing uncertainty and maintaining consistency across SC-GHG estimates.

The IWG used three discount rates (2.5%, 3%, and 5%) centered around the 3% estimate of the consumption rate of interest. To its credit, the IWG did not follow the recommendation in OMB's Circular A-4 to provide estimates using discount rates of both 3% and 7%.[368] OMB's estimate of the consumption rate of interest was based on the real rate of return on 10-year Treasury Securities from 1973–2002, which averaged 3.1%.[369] In its 2021 TSD, the IWG admitted that re-estimating the consumption rate of interest using the same approach applied by the OMB in 2003 but based on the real rate of return on 10-year Treasury Securities from 1991–2020 (as opposed to 1973–2002) results in a significantly lower average estimate of 2.0%.[370] According to the Board of Governors of the U.S. Federal Reserve System "10-Year Treasury Inflation-Indexed Security" report, the average real rate of return on 10-year Treasury Securities from 2003–2021 was 1.01%.[371] To be clear, in its May 2022 Budget and Economic Outlook, CBO suggested that this rate may now be changing.[372] It projected that interest rates on ten-year Treasury notes would rise from 1.5% at the end of 2021 to 2.7% by the end of 2022 and 3.8% in 2028 and beyond.[373] Nonetheless, it previously predicted that real rates of return on 10-year Treasury Securities would average 1.2% over the next 30 years.[374] Thus, a higher discount rate, based upon the ten-year Treasury Security note might be justified in 2022, but it was arguably not justified in the decade that ended in 2021. A 2018 study surveyed over 200 economics experts and over three quarters of those surveyed agreed that a central discount rate of 2% was appropriate in 2018 for monetizing a stream of future damages in terms of reduced consumption in present-day values.[375]

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368 CIRCULAR A-4, *supra* note 188, at 33–34.

369 2021 TSD, *supra* note 219, at 19.

370 *Id.* at 19–20.

371 Tamma Carleton and Michael Greenstone, *Updating the United States Government's Social Cost of Carbon* 23 (Energy Policy Inst. at the Univ. of Chicago, Working Paper No. 2021-04, Nov. 2021), https://perma.cc/323E-JMX9.

372 U.S. CONG. BUDGET OFF., THE BUDGET AND ECONOMIC OUTLOOK: 2022 TO 2032, NO. 57950 (2022), https://perma.cc/3E9C-528P.

373 *Id. at* 23, 40; *see also Analysis of CBO's May 2022 Budget and Economic Outlook*, COMM. FOR A RESPONSIBLE FED. BUDGET (May 25, 2022), https://perma.cc/ZWH8-SBDP ("CBO projects the interest rate on ten-year Treasuries will rise further to 3.8 percent by 2028 and beyond.").

374 2021 TSD, *supra* note 219, at 20 (citing U.S. CONG. BUDGET OFF., THE 2020 LONG-TERM BUDGET OUTLOOK, NO. 56516, at 57 (2020), https://perma.cc/K4FU-GGWF).

375 Moritz Drupp et al., *Discounting Disentangled*, AM. ECON. J.: ECON. POL'Y, Nov. 2018, at 109, https://perma.cc/R9BW-BQQD; *see also* 2021 TSD, *supra* note 219, at 20 (confirming that studies show consensus among experts on the 2% rate).

In a paper published in January 2021, economists Tamma Carleton of the University of California, Santa Barbara, and Michael Greenstone of the University of Chicago recommended that the IWG under the Biden administration use a central discount rate of no higher than 2%.[376] Although the IWG acknowledged in its 2021 TSD that the 3% estimate of the consumption rate of interest was no longer the most accurate estimate available in economic literature, the IWG ultimately endorsed the continued near-term use of the 2.5%, 3%, and 5% constant discount rates established under the Obama administration.[377] In light of recent changes in interest rates, that decision might prove prescient, but going forward, the IWG should set the discount rate based strictly on the rates of return for ten-year Treasury Securities notes.

As previously noted, the IWG uses three constant certainty-equivalent discount rates to calculate the SC-GHG estimates. However, since the IWG committed to this discounting approach, leading climate economists have agreed that a declining discount rate (as opposed to constant discount rates) would better account for long-term uncertainty in discount rates.[378] Long-term uncertainty in discount rates stems from uncertainties in future economic growth, consumption, and the interest rate used by consumers, and this uncertainty increases exponentially over time.[379] Both the NASEM in its 2017 report and the EPA's Science Advisory Board in 2021 recommended that the IWG develop and apply a declining discount rate schedule to all regulatory impacts (both near-term and long-term), as is done in the UK and France.[380] This practice better accounts for the effects of uncertainty on future discount rates.

E. An EPA Proposal for a Different Approach to the Social Cost of GHGs

In September 2022, the EPA proposed a substantially different approach to estimating the social cost of GHGs. Although a member of the IWG, the EPA proposal would no longer rely on the three IAMs (DICE, FUND, and PAGE) to estimate the SC-GHGs. Rather, the EPA proposal takes a modular approach as recommended by the National Academies.[381] The apparent purpose of the EPA proposal is to respond to the many criticisms of the models used in the earlier IWG reports and to incorporate methodological updates recommended by the National Academies.[382] The result is a much higher estimate of the social cost of CO2: $190 per ton at a 2% discount rate in 2020, with separate figures

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376 Carleton & Greenstone, *supra* note 371, at 21–22.

377 2021 TSD, *supra* note 219, at 4.

378 PAUL ET AL., *supra* note 128, at 19.

379 *Id.*

380 2021 TSD, *supra* note 219, at 22; *see also* Maureen L. Cropper et al., *Declining Discount Rates*, 104 AM. ECON. REV. 538, 542 (2014), https://perma.cc/KX96-RY5E (recommending U.S. adoption of a declining discount schedule as used in France and the U.K.).

381 EPA REPORT ON SC-GHG, *supra* note 129, at 1.

382 *Id.*

for CH4 ($1,600 per ton at a 2% discount rate), and N2O ($54,000 per ton at a 2% discount rate).[383]

The four modules proposed for the SC-GHG estimation process are: 1) socioeconomics and emissions; 2) climate science; 3) economic damages; and 4) discounting.[384] Each module component is analyzed using, what EPA claims, is the latest research and expertise relevant to that component.[385] More specifically, the report describes the approach to analyzing the data relevant to the four modules as described below.

The socioeconomic and emissions module relies on long-term projections on population, gross domestic product, and GHG emissions as developed by the Resources for the Future, Social Cost of Carbon Initiative.[386] According to the EPA, the reason for focusing on these parameters is that "holding all else equal, increases in population and income will increase GHG emissions."[387] Furthermore, because "GHG emissions are long-lived," projection must be made "far into the future" to account for the significant uncertainties associated with these projections.[388]

The climate module is designed to estimate the effect of GHG emissions on the physical environment. As described by the EPA, the climate module must:

1. translate GHG and other forcing agent emission projections into atmospheric concentrations, accounting for the uptake of CO2 by the land biosphere and the ocean and the removal of other greenhouse gases through atmospheric reactions, deposition, and/or other mechanisms;
2. translate concentrations of greenhouse gases and other forcing agents into radiative forcing;
3. translate forcing into global mean surface temperature response, accounting for heat uptake by the ocean, and
4. generate other climatic variables, such as sea level rise (SLR), that may be needed by the damage module.[389]

The climate module relies on an Earth system model recommended by the National Academies called the Finite Amplitude Impulse Response (FaIR) model.[390]

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383 *Id.* at 3 tbl.ES.1.

384 *Id.* at 1, 8–9.

385 *Id.* at 1, 84.

386 *Id.* at 1, 19, 44; Brian C. Prest et al., *The Social Cost of Carbon: Reaching a New Estimate*, RESOURCES (Sept. 1, 2022), https://perma.cc/B97T-4QKT.

387 EPA REPORT ON SC-GHG, *supra* note 129, at 18.

388 *Id.* at 18, 52.

389 *Id.* at 26.

390 *Id.* at 28–29, 28 n.58 (EPA's SC-GHG estimates relied on FaIR version 1.6.2 rather than a more recent 2.0 version because the latter version does not track ocean heat uptake, which can be used to project future sea level rise.). *See generally FaIR: Finite Amplitude Impulse Response simple climate model*, FAIR, https://perma.cc/Y5UQ-L6VJ (last vis-

The damage module "translates changes in temperature and other physical impacts of climate change into monetized estimates of net economic damages."[391] The EPA found that the DICE, FUND, and PAGE models used in the IWG GHG estimates now lag behind current research.[392] In lieu of these models, the EPA relies on three alternative sources—the Data-driven Spatial Impact Model (DSCIM); the Greenhouse Gas Impact Evaluator Estimator (GIVE); and a meta-analysis, which synthesizes information from published climate damages literature. As described by the EPA, DSCIM "monetizes climate damages for nearly 25,000 global impact regions."[393] The model takes local conditions and adaptation investments into account and then aggregates local damages to estimate global damages in relation to changes in global temperature in five sectors: health, energy, labor production, agriculture, and coastal regions.[394] GIVE is an integrated assessment model developed by the Resources for the Future, Social Cost of Carbon Initiative in response to the National Academies recommendations.[395] GIVE estimates climate damages in four sectors—health, energy, agriculture, and coastal regions—using methods similar to those employed in the DSCIM.[396] Finally, the EPA uses the meta-analysis prepared by Howard and Sterner in 2017, which synthesizes data from 20 studies from the climate damage literature that were published through 2015.[397]

The EPA deserves credit for taking on and responding to, the critique offered by the National Academies directly. No doubt, the EPA draft proposal marks a significant step forward in grounding the SC-GHG in the latest scientific data available. But the very complexity of the issue ensures that the newest projections will receive their fair share of criticism. The numbers alone, which would raise the SC-GHGs almost four times the current IWG numbers, could significantly alter the cost-benefit calculus for many future federal proposals.[398] On the other hand, much of the criticism leveled at the EPA proposal thus far suggests that the numbers are still too low.

Two particular criticisms have been leveled against the EPA's draft proposal. First, it fails to address damage categories that are difficult to quantify. These include damages from increases in the number and severity of wildfires, damages from ocean acidification, damages that

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ited Sept. 9, 2023) (describing FaIR as "a reduced-complexity climate model useful for scenario assessment and idealised climate runs").

391 EPA REPORT ON SC-GHG, *supra* note 129, at 37, 127.

392 *Id.* at 37.

393 *Id.* at 39.

394 *Id.* at 39–40.

395 *Id.* at 44.

396 *Id.* at 44–45 (The DSCIM addresses the same sectors at the GIVE model but adds a labor production sector).

397 *Id.* at 47–48.

398 Steve Novick, *Social Cost of Carbon Metric Still Omits Major Climate Damages*, BLOOMBERG L. (Dec. 6, 2022), https://perma.cc/WCH5-SMFH.

will occur after 2300, and damage to historic and cultural resources.[399] Second, it uses a "willingness to pay" for a reduction in the risk of dying from climate-related impacts as the basis for valuing human life.[400] Willingness to pay seems a fraught approach to valuing life since it necessarily reflects an ability to pay, which will be higher for wealthier people and in wealthier countries. Moreover, since the willingness to pay is entirely hypothetical and people do not actually have to put up any money, one might claim a willingness to pay much more than they are able to pay since their willingness is based entirely on the hypothetical risk of dying from climate impacts. This leads to widely disparate numbers depending on where a person lives. Specifically, EPA "weigh[s] the mortality costs of climate change in proportion to per capita income of the country."[401] So, for example, a life lost in Canada is worth 16 times a life lost in Haiti, which has a much smaller per capita income.[402] This is particularly problematic given the gross disparities in income within countries, including within the United States.[403] Taken to its logical conclusion, EPA should value the life of a District of Columbia resident more than twice that of a Mississippian.[404]

The "willingness to pay" approach to valuing the lives of foreigners is also problematic in the context of assessing the costs and benefits of American proposals because it reflects what foreigners are willing to pay to reduce their risk of dying rather than what Americans are willing to pay for those foreign lives.[405] Of course, treating all lives as equally valuable could increase EPA's estimate of the SC-GHG significantly. One expert has suggested that such an approach might be nearly double the estimate with variable values.[406]

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399 *Id.*

400 *See* Dylan Matthews, *The Tricky Business of Putting a Dollar Value on a Human Life*, VOX (Dec. 22, 2022), https://perma.cc/YNR4-RTJ2 (noting EPA bases value of life on GDP).

401 *Id.*

402 *Id.*

403 *See* U.N. DEP'T OF ECON. & SOC. AFFAIRS, WORLD SOCIAL REPORT 2020: INEQUALITY IN A RAPIDLY CHANGING WORLD, at 22–23, U.N. Doc. ST/ESA/372, U.N. Sales No. E.20.IV.1 (2020) (illustrating that absolute income disparities are found within and across countries).

404 Per capita income in the District of Columbia is $84,538; it is just $39,368 in Mississippi. *Per Capita Income by State*, WORLD POPULATION REV., https://perma.cc/ZUF4-NY4Q (last updated Jan. 2023).

405 *See* Matthews, *supra* note 400 (explaining proposed policy consequences of estimating of how much individuals in a particular group are willing to pay to reduce their risk of dying on an intranational and international level).

406 Rebecca Hersher, *Why the EPA Puts a Higher Value on Rich Lives Lost to Climate Change*, NPR (Feb. 8, 2023, 5:00 AM), https://perma.cc/4R7K-TPJJ (summarizing a study published by Tamma Carleton).

VI. ENVIRONMENTAL AND SOCIAL GOVERNANCE

A. Introduction to ESG

Legal obligations aside, investment companies and private organizations have increasingly embraced their responsibility to structure their activities so as to meet their ethical and moral obligations to protect environmental and social values, and to govern their enterprise to meet diversity, equity, and inclusion goals.[407] This commitment often falls under the rubric "environmental, social, and governance" (ESG), a term that has been used interchangeably with "corporate social responsibility" (CSR).[408] For this reason, references to ESG in this article should be understood to encompass the related concept of CSR.

Pressure to establish ESG policies comes from a wide range of stakeholders, including shareholders, investors, and consumers. What this means and how it translates into organizational decisionmaking in practice, however, is far from clear.[409] The section below is intended to offer guidance to organizations seeking to meet ESG goals. This may prove helpful not only for organizations committed to those goals, but also to other stakeholders, including the general public, who may wish to measure an organization's success in achieving ESG policies.

As the acronym suggests, ESG focuses on three principles.[410] The environmental prong addresses an organization's performance as a steward of the natural environment. It further addresses waste, pollution, resource depletion, GHG emissions, deforestation, and climate change generally.[411] The social prong asks how the organization relates to people, including relations with employees and communities affected by their work; this includes diversity in hiring practices, safe working conditions, meaningful engagement with local communities, and respect for community choices.[412] Governance contemplates corporate policies that reflect strong morals, ethics, and equity, such as compensating executives and employees fairly, structuring charitable donations and political work to reflect ESG values, promoting board diversity and

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407 *See Environmental, Social and Governance (ESG) Funds—Investor Bulletin*, SEC. & EXCH. COMM'N (Feb. 26, 2021), https://perma.cc/RAS2-NWET (explaining the number of organizations that incorporate ESG factors into their decisions has increased dramatically in recent years and is expected to continue to rise as investors emphasize evaluating organizations holistically).

408 *ESG Reporting*, EY, https://perma.cc/PR7J-PTNP (last visited Sept. 9, 2023).

409 Linda-Eling Lee, What Does ESG Investing Really Mean? Measuring Materiality, Presentation at the Wharton School Pension Research Council Symposium: Sustainable Investment in Retirement Plans 1 (Apr. 29–30, 2021), https://perma.cc/6ZS8-GSP5.

410 *What is ESG? Definition and Meaning*, MKT. BUS. NEWS, https://perma.cc/6YLG-L7BW (last visited Sept. 9, 023).

411 *Id.*

412 *See id.* (noting focus on company treatment of local communities).

designing a transparent decision structure.[413] According to a PricewaterhouseCoopers survey, 83% of consumers believe companies should be actively shaping ESG best practices, 91% of business leaders believe their company has a responsibility to act on ESG issues, and 86% of employees prefer to support or work for companies that care about these issues.[414]

An enormous challenge in meeting ESG goals is the lack of organizational transparency in demonstrating compliance with ESG.[415] The lack of reliable ESG information contributes to "greenwashing," whereby organizations claim to meet higher environmental standards than is justified by their performance.[416] This phenomenon makes companies with high emissions rates seem attractive for investment despite their true environmental effects.[417]

B. An ESG Policy

ESG policies will vary considerably depending on the organization's mission and area of business. The policies relevant to investment companies, for example, will look quite different from those that might apply to a manufacturing, mining, or service-oriented business. In every case, however, an ESG strategy should begin with good process. At the outset, and to the fullest extent possible, organizations should commit to transparency about their process, and about the ESG policies they adopt. With this in mind, organizations should circulate a draft policy to stakeholders, including investors, shareholders, employees and other interested parties, soliciting their ideas for how to improve and implement the proposed ESG policy. Also, because ESG practices are constantly evolving, the policy should be nimble, and readily adaptable so that it can respond effectively to new information and changing conditions.

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413 *Id.*; *see also* Farah Imrana Hussain & Rodrigo Cabral, *Greater Transparency on Environmental, Social and Governance (ESG) Issues: New Focus for Sovereign Debt Issuers*, WORLD BANK BLOGS (Sept. 9, 2019), https://perma.cc/7TWW-GVVL (discussing bonds that require disclosure of how proceeds are used).

414 *Beyond Compliance: Consumers and Employees Want Business to do More on ESG*, PWC, https://perma.cc/UBF9-SXLG (last visited Sept. 11, 2023).

415 MARCUS ARCANJO, DOING WELL BY DOING GOOD: ENVIRONMENTALISM AND THE ROLE OF RESPONSIBLE INVESTING (2020).

416 *Greenwash*, CAMBRIDGE DICTIONARY, https://perma.cc/4B8Y-7SF4 (last visited Sep. 7, 2023) (defining "greenwash" as "to make people believe that your company is doing more to protect the environment than it really is").

417 *See id.* Moreover, 66% questioned the genuineness of some of their organization's sustainability initiatives. Justin Keeble, *Report: What it will take for CEOs to fund a sustainable transformation*, GOOGLE CLOUD (April 13, 2022), https://perma.cc/ZA76-B8LS.

C. Environmental Standards and Goals

On the environmental side, the ESG policy must reflect the organization's business. ESG policies for an organization that refines oil will look quite different from one that logs timber. So, to the extent relevant, the policy should include specific information and goals on pollution emissions, chemical use, waste generation, resource depletion, recycling and reuse of materials, and deforestation. In addition, it should account for the organization's climate emissions and related impacts, and it should set goals for minimizing its emissions and impacts. The Task Force on Climate-Related Financial Disclosures (TCFD), created by the Financial Stability Board, is a voluntary disclosure tool that organizations can use to address their climate impacts.[418] The proposed SEC Disclosure Rule, which is discussed below, would set mandatory disclosure requirements. The SEC used the TCFD tool to develop its proposal.[419]

The environmental policy should also establish specific commitments and goals for transitioning to renewable energy to meet the organization's electric power needs. More generally, the policy should lay out the organization's carbon footprint and sustainability policies, including its approach to using supply chains that meet the organization's own commitment to addressing climate change.

D. Social Standards and Goals

On the social side, the organization should set forth its policy on executive compensation, including efforts to address gross disparities between executive and employee compensation. A 2021 study by the Economic Policy Institute found that "the ratio of CEO-to-typical-worker compensation [in 2020] was 351-to-1."[420] One year earlier it was 307-to-1.[421] In 1989 it was 61-to-1, and in 1965, 21-to-1.[422] The study found that much of the problem stems from stock-related compensation and was not necessarily due to increased productivity.[423] According to the study, "[t]he economy would suffer no harm if CEOs were paid less (or were

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418 *See Task Force on Climate-related Financial Disclosures*, TASK FORCE ON CLIMATE-RELATED FIN. DISCLOSURE, https://perma.cc/9ZMH-LTLY (stating that the Financial Stability Board created the TCFD to improve ad increase reporting of climate-related financial information) (last visited Oct. 1, 2023).

419 The Enhancement and Standardization of Climate-Related Disclosures for Investors, 87 Fed. Reg. 21334, 21346 (proposed Apr. 11, 2022) (to be codified at 17 C.F.R. pts. 210, 229, 232, 239, 249).

420 LAWRENCE MISHEL & JORI KANDRA, ECON. POL'Y INST., CEO PAY HAS SKYROCKETED 1,322% SINCE 1978 1 (2021), https://perma.cc/4RFF-5GLK.

421 *Id.*

422 *Id.* Fortune Magazine estimated the pay gap at 399 to 1 in 2021. Chloe Berger, *The Executive-worker Pay Gap Keeps Getting Bigger as CEOs Rake in an Average $27.8 Million a Year*, FORTUNE (Oct. 7, 2022, 7:45 AM), https://perma.cc/3TQ4-94YE.

423 MISHEL & KANDRA, *supra* note 420, at 1.

taxed more)."[424] Income inequality is a global problem and, as the data suggests, has been growing worse over time.[425] A reasonable ESG goal would seek to drive down the ratio between executive pay and that of the typical worker.

An organization's policy on and commitment to inclusion and diversity should also be addressed in the social section of the ESG policy. Diversity can be defined in many different ways, but it should at a minimum recognize the importance of bringing in employees and managers with diverse educational, racial, and ethnic backgrounds, and it should focus especially on those who have been disadvantaged due to socioeconomic factors.[426]

Finally, the organization should describe its outreach to the communities that it serves, including its commitments, financial or otherwise, to those communities. Large organizations benefit greatly from the infrastructure that their local communities provide.[427] This includes a wide range of amenities such as schools, parks, libraries, roads, and water and sewage treatment. While these amenities greatly benefit an organization and its employees, the broader community largely subsidizes them.[428] Recognizing this, organizations should commit to improving local infrastructure commensurate with, and perhaps even beyond the value that they receive. After all, much of the infrastructure that they rely upon was likely built long before their arrival in the community.

E. Governance Standards and Goals

On governance, the organization's ESG policy should set goals for diversity at all levels of employment as well as on any boards of directors. It should also identify and address issues relating to its supply chains, including a commitment to sourcing materials from countries and organizations that meet strict ethical and sustainable practice standards. For example, a company that makes electric vehicle batteries that use cobalt, and that has historically sourced that cobalt from the Democratic Republic of Congo (DRC), should recognize concerns over problematic environmental and labor practices in the

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424 *Id.*

425 LUCAS CHANCEL ET AL., WORLD INEQ. LAB, WORLD INEQUALITY REPORT 2022 27–28 (2022), https://perma.cc/LB89-EVY9.

426 *See* Natasha Nicholson, *The Forgotten People: DEI and Socioeconomic Class*, TALENT MGMT. (Sept. 26, 2022), https://perma.cc/PZB8-CKQK (discussing the impact of socioeconomic status on workplace interactions and providing ways to address socioeconomic class as part of diversity, equity, and inclusion efforts).

427 *How Infrastructure Impacts Business* U.S. CHAMBER OF COM. (Sept. 15, 2021), https://perma.cc/TAY5-RURK.

428 *See* Reimagining the Civic Commons, *How do Public Spaces Strengthen Local Economies? Here Are 4 Ways*, MEDIUM (Apr. 25, 2023), https://perma.cc/M744-6AXK (noting that investment in parks contribute to economic growth and enhance the business environment).

DRC, including child labor in their cobalt mines.[429] The company should establish a policy that allows it to move away from sourcing cobalt in the DRC, or perhaps in the alternative, that embarks on a program to reform the DRC's historical mining policies as a condition for sourcing cobalt from that country in the future.[430]

Perhaps most critically, an organization's governance policy should commit to periodic monitoring and reporting on its success in meeting the goals and commitments established in the ESG policy. The popular SMART approach, recently updated as the SMARTIE approach, should be employed to measure the organization's success in achieving its ESG goals. SMARTIE goals are "Strategic, Measurable, Ambitious, Realistic, Time-bound, Inclusive, and Equitable."[431] Regularly measuring an organization's ESG performance with SMARTIE goals, publishing the results, adapting its policies and practices as necessary to meet its commitments, and periodically revising its goals to reflect new information that comes in from the monitoring program, are all important steps in implementing an effective and meaningful ESG policy.[432]

F. Mandatory Disclosure Requirements in the EU and US

ESG standards have the potential to fundamentally alter corporate culture, but at present they are neither well-defined nor legally binding. Although no country has mandated substantive standards that reflect ESG principles, the EU has established mandatory standards for disclosure of sustainability risks, with an express goal of promoting ESG principles.[433] The U.S. Securities and Exchange Commission (SEC) now appears poised to follow the EU's lead, although the SEC rules will focus more explicitly on climate-related risks.[434]

Although these actions do not specifically address any of the important substantive issues that arise when establishing ESG standards, disclosure of information about an organization's

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429 Terry Gross, *How 'Modern Day Slavery' in the Congo Powers the Rechargeable Battery Economy*, NPR (Feb. 1, 2023, 12:38 PM), https://perma.cc/DA36-7D6S.

430 Katharine Houreld & Arlette Bashizi, *Despite Reforms, Mining for EV Metals in Congo Exacts Steep Cost on Workers*, WASH. POST (Aug. 4, 2023, 5:00 PM), https://perma.cc/PJ4W-DXUA.

431 *SMARTIE Goals Worksheet*, MGMT. CTR. (May 10, 2021), https://perma.cc/QAL3-VY7B.

432 *See* Kezia Farnham, *ESG Policies: Why It's Vital, What to Include and Best Practices*, DILIGENT (Oct. 19, 2022), https://perma.cc/BV6N-D8S2 (recommending that organizations create measurable ESG policies and reassess those policies regularly as the organization's priorities and success measures advance).

433 Council Regulation 2019/2088, 2019 O.J. (L 317) 1, 9 (defining "sustainability risk" as "an environmental, social or governance event or condition that, if it occurs, could cause an actual or potential material negative impact on the value of [an] investment").

434 The Enhancement and Standardization of Climate-Related Disclosures for Investors, 87 Fed. Reg. 21334 (proposed Apr. 11, 2022) (to be codified at 17 C.F.R. pts. 210, 229, 232, 239, 249).

sustainability risks, including climate-related risks, could nonetheless prove a powerful tool in applying public pressure on organizations to adopt substantive standards.

1. The EU's Sustainable Finance Disclosure Regulation

The EU's Sustainable Finance Disclosure Regulation (SFDR) took effect in March 2021.[435] The stated goal of the rule is "to improve transparency in the market for sustainable investment products, to prevent greenwashing and to increase transparency around sustainability claims made by financial market participants."[436]

Here is how one consulting firm explained the SFDR:

> The SFDR provides a roadmap to all financial market participants (FMPs) and financial advisers in the EU that consist of investment firms such as asset managers, insurance companies, pension providers, banks, venture capital funds, and credit institutions offering portfolio management or financial advice. FMPs with more than 500 employees are required to report on a set of Principal Adverse Impact (PAI) indicators and how they incorporate them in their investment decision process.[437]

The SFDR requires transparency in order to prevent greenwashing and promote better decision, with the ultimate goal is to shift capital towards more sustainable activities.[438]

In April 2022, the European Supervisory Authorities (ESA) issued final Regulatory Technical Standards (RTS), which included templates for disclosure by organizations that are subject to the rule.[439] The European Parliament and Council must still approve the RTS, however; as written, the current version of the RTS includes specific indicators for applicable investors related to climate and other environment-related matters.[440]

2. The Proposed SEC Disclosure Rule

The proposed SEC rules would require domestic and foreign SEC registrants to disclose climate-related risks that may have a material impact on a company's business, results of operations, or financial condition.[441] If adopted, the rules will require registrants to disclose

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435 *SFDR*, EUROSIF, https://perma.cc/R9D7-FZPM (last visited Sept. 11, 2023).

436 *Id.*

437 *All About Sustainable Finance Disclosure Regulation (SFDR)*, IRIS CARBON (June 2, 2022), https://perma.cc/4FH5-H5TL.

438 *Id.*

439 Commission Regulation 2022/1288, 2022 O.J. (L 196) 1, 6.

440 *Id.* at 14.

441 The Enhancement and Standardization of Climate-Related Disclosures for Investors, 87 Fed. Reg. 21334 (proposed Apr. 11, 2022) (to be codified at 17 C.F.R. pts. 210, 229, 232, 239, 249).

certain climate-related information in their registration statements and other reports, including:

- Climate-related risks and their actual or likely material impacts on the registrant's business, strategy, and outlook;
- The registrant's governance of climate-related risks and relevant risk management processes;
- The registrant's greenhouse gas ("GHG") emissions, which, for accelerated and large accelerated filers and with respect to certain emissions, would be subject to assurance;
- Certain climate-related financial statement metrics and related disclosures in a note to its audited financial statements; and
- Information about climate-related targets and goals, and transition plan, if any.[442]

The rules would also require quantification of the registrant's direct (Scope 1) GHG emissions, their indirect (Scope 2) emissions, and in some cases, indirect emissions from upstream and downstream activities (Scope 3).[443] As the SEC has noted, the proposed disclosures are consistent with broadly accepted disclosure frameworks established by the Taskforce on Climate-related Financial Disclosures and the Greenhouse Gas Protocol.[444]

In its proposal, the SEC acknowledged that many organizations already disclose much information about climate risks in their proxy statements, sustainability reports, and on their websites, but the SEC also observed that these disclosures vary greatly in terms of quality and completeness.[445] Moreover, the SEC concluded that because existing disclosure standards are voluntary, they are inadequate to respond to the risk posed by climate change.[446]

Rather than adopting a new standalone regulation, as some commenters recommended, the SEC proposed to include the climate-related disclosure rules in Regulations S-K and S-X.[447] Regulation S-K outlines how registrants should disclose material qualitative descriptors of their business on registration statements, periodic reports, and other filings.[448] Regulation S-X outlines the specific form and content of financial statements that are required by the SEC.[449] The agency reasoned that full disclosure of climate-related risks, including financial

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442 U.S. SEC. & EXCH. COMM'N, ENHANCEMENT AND STANDARDIZATION OF CLIMATE-RELATED DISCLOSURES FACT SHEET 1 (2022), https://perma.cc/EJ7P-FEDN.

443 *Id.* at 2.

444 *Id.* at 1.

445 The Enhancement and Standardization of Climate-Related Disclosures for Investors, 87 Fed. Reg. 21334.

446 *Id.* at 21340.

447 *Id.* at 21348.

448 *Id.* at 21340.

449 *Id.* at 21348.

risks, is critical to an investor's understanding of the business and its operating prospects and financial performance.[450] The proposal would require climate-related disclosures in a separately captioned "Climate-Related Disclosure" section and in the organization's financial statements.[451]

VII. CONCLUSION

It is truly remarkable that scientists, government agencies, and NGOs have identified a path that allows decisionmakers and the public to quantify the GHG emissions that result from proposed actions and that fairly accounts for them in their ultimate decisions. To be sure, the path remains rocky because it depends on an excellent EIA process, accurate accounting of GHG emissions, and an accurate estimate of the SC-GHGs. None of these are assured. But we can improve the EIA process and we can strive for better emissions accounting and a more reliable estimate of the SC-GHG. Perhaps for now it is enough to celebrate that however rough it may be, the path can, at least, be discerned.

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450 *Id.*

451 *Id.* For example, Proposed Rule § 210.14-02(c) would require that companies disclose the financial impacts of severe weather events, other natural conditions and transition activities on a relevant line item in the company's financial statements. *Id.* at 21464.