Institute for Policy Integrity
NEW YORK UNIVERSITY SCHOOL OF LAW

December 16, 2016

California Air Resources Board
VIA ELECTRONIC SUBMISSION

Subject: Comments on Discussion Draft, 2030 Target Scoping Plan Update (Dec. 2, 2016)

The Institute for Policy Integrity at New York University School of Law[1] ("Policy Integrity") respectfully submits the following comments[2] on the California Air Resource Board's ("ARB") Discussion Draft of its 2030 Target Scoping Plan Update.[3] Policy Integrity is a non-partisan think tank dedicated to improving the quality of government decisionmaking through advocacy and scholarship in the fields of administrative law, economics, and public policy. Policy Integrity regularly conducts economic and legal analysis on the appropriate use of the social cost of carbon, among other environmental and economic topics.

California recently extended its greenhouse gas emissions reduction program to 2030 with two bills, Senate Bill 32 ("SB 32") and Assembly Bill 197 ("AB 197"). These bills also modify how ARB shall assess and prioritize goals in designing regulations. Accordingly, ARB is drafting a new scoping plan for how to achieve the 2030 targets. ARB staff released a "discussion draft" of the updated scoping plan and has invited public comments on this initial draft. These comments make recommendations on how to structure the plan's economic analysis to best achieve the goals laid out in ARB's new statutory mandate.

Among other provisions, AB 197 requires ARB to consider the social cost of greenhouse gas emissions and the avoided social costs of proposed compliance measures.[4] In order to comply with the statute and consider the full range of effects of the policy options in the updated scoping plan, ARB should:

- Use the federal social costs of carbon, methane and nitrous oxide, as most recently updated in August 2016, subject to further updates that are consistent with the best available science and economics; and

- Use cost-benefit analysis, in addition to its usual cost-effectiveness analysis.

[1] No part of this document purports to present New York University School of Law's views, if any.
[2] These comments incorporate by reference into the record all of the documents cited herein.
[3] Cal. Air Res. Bd., 2030 Target Scoping Plan, Discussion Draft. (Dec. 2, 2016) [hereinafter "Discussion Draft"].
[4] Cal. Health & Safety Code §§ 38562.5 & 38562.7.

I. In its economic analysis, ARB should use the federal social cost of carbon, social cost of methane and social cost of nitrous oxide, which are the best available estimates of the damages associated with the emissions of each additional ton of these greenhouse gases[5]

AB 197 requires ARB to "consider the social costs of the emissions of greenhouse gases" when it is "adopting rules and regulations" to reduce greenhouse gases below 1990 levels.[6] The statute defines "social costs" as:

> an estimate of the economic damages, including, but not limited to, changes in net agricultural productivity; impacts to public health; climate adaptation impacts, such as property damages from increased flood risk; and changes in energy system costs, per metric ton of greenhouse gas emission per year.[7]

In selecting the appropriate metric to use for the "social costs of the emissions of greenhouse gases," ARB should choose a value that reflects the best available science and economics and has been developed through a transparent process. The August 2016 updated federal Interagency Working Group on Social Cost of Greenhouse Gases ("IWG") reports[8] reflect the best available estimates of the damages associated with the emission of each additional ton of carbon dioxide, methane, and nitrous oxide, through the federal social cost of carbon ("SC-CO_2"), federal social cost of methane ("SC-CH_4"), and federal social cost of nitrous oxide ("SC-N_2O").[9]

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[5] These comments draw from coalition comments on the social cost of carbon and social cost of methane, filed jointly in major federal rulemakings by Policy Integrity, the Environmental Defense Fund, the Natural Resource Defense Council, and the Union of Concerned Scientists. *See* Environmental Defense Fund, Institute for Policy Integrity at New York University School of Law, Natural Resources Defense Council, and Union of Concerned Scientists, Comments on Energy Conservation Standards for WICF Refrigeration Systems & Energy Conservation Standards for Residential Furnaces (Nov. 17, 2016) [hereinafter "Joint SC-CO_2 Comments"] (most recent version of these joint comments) (attached as Exhibit A).

[6] Cal. Health & Safety Code § 38562.5.

[7] Cal. Health & Safety Code § 38506.

[8] INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, UNITED STATES GOVERNMENT, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 (2016) [hereinafter "2016 TSD"], *available at* https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf; INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, UNITED STATES GOVERNMENT, 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 TSD ADDENDUM"], *available at* https://www.whitehouse.gov/sites/default/files/omb/inforeg/august_2016_sc_ch4_sc_n2o_addendum_final_8_26_16.pdf.

[9] These comments will use the terms "SC-CO_2," "SC-CH_4," and "SC-N_2O" to refer to the general concept of the valuation of a social cost of a ton of emission of the specified greenhouse gas, and will use the terms "federal SC-CO_2," "federal SC-CH_4," and "federal SC-N_2O" to refer to the specific sets of consensus valuations developed by the Interagency Working Group.

In response to a Ninth Circuit Court of Appeals decision that required the government to account for the economic effects of climate change in a regulatory impact analysis of fuel efficiency standards,[10] the federal government convened the IWG to develop a SC-CO_2 value for use in federal regulatory analysis. Prior to the formation of the IWG, agencies used a range of values for the economic harm caused by one additional metric ton of carbon dioxide emissions.[11] The consistent use of the IWG estimates in federal rulemaking allows agencies to harmonize their approach to conducting regulatory impact analyses and conserve agency resources to avoid duplication of modeling effort. The IWG has met several times to update its modeling based on updated scientific literature, with the most recent update in 2016, reflecting recommendations on SC-CO_2 from the National Academy of Sciences and expanding the analysis to include additional greenhouse gases, specifically methane and nitrous oxide.[12]

The IWG's August 2016 central estimate[13] of $41 in 2016 dollars per ton of carbon dioxide emissions is based on the best available science.[14] As ARB's Discussion Draft notes,[15] this value is likely an underestimate because some forms of damage, like catastrophic risks, are omitted from present calculations due to data limitations and scientific uncertainty.[16] Nonetheless, the federal SC-CO_2 is the best available estimate of climate damages and has been used in almost one hundred federal regulations and a number of state proceedings.[17] Additionally, the Seventh Circuit Court of Appeals recently approved the federal SC-CO_2's

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

[11] INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, UNITED STATES GOVERNMENT, TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866, at II-3 (2010) [hereinafter "2010 TSD"], *available at* https://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf.

[12] *See* 2016 TSD, *supra* note 8; 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), *available at* https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf; INTERAGENCY WORKING GROUP ON THE SOCIAL COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 (2013) [hereinafter "2013 TSD"], *available at* https://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf; 2010 TSD, *supra* note 11.

[13] As discussed further in Section I.C, the IWG produced a range of social cost of carbon estimates, reflecting a 5-percent discount rate, a 3-percent discount rate, a 2.5-percent discount rate, and a 95th percentile estimate. This $41 per ton figure corresponds to the "central" 3-percent discount rate.

[14] 2016 TSD, *supra* note 8, at 4, tbl.ES-1 (showing a value of $36 in 2007 dollars, which yields $41 in 2016 dollars when updated using a Consumer Price Index Inflation Calculator, http://data.bls.gov/cgi-bin/cpicalc.pl).

[15] Discussion Draft, s*upra* note 3, at 113.

[16] *See* Richard L. Revesz et al., *Improve Economic Models of Climate Change*, 508 NATURE 173 (2014) (co-authored with Nobel Laureate Kenneth Arrow, among others) (attached as Exhibit B); 2010 TSD, *supra* note 11; PETER HOWARD, OMITTED DAMAGES: WHAT'S MISSING FROM THE SOCIAL COST OF CARBON (2014) [hereinafter "OMITTED DAMAGES"] (attached as Exhibit C); Peter Howard, Flammable Planet: Wildfires and the Social Cost of Carbon (2014); The Cost of Carbon Pollution, http://costofcarbon.org/.

[17] JANE A. LEGGETT, CONGRESSIONAL RESEARCH SERVICE, FEDERAL CITATIONS TO THE SOCIAL COST OF GREENHOUSE GASES (2016); see discussion of state proceedings in Section I.D below.

use by a federal agency.[18] The federal SC-CH_4 and federal SC-N_2O have been developed more recently, but are also based upon a similarly rigorous IWG process.[19]

These federal SC-CO_2, SC-CH_4, and SC-N_2O estimates are firmly grounded in peer-reviewed science and economics. Furthermore, they have been developed through a transparent and ongoing process coordinated by experts and incorporating public comment. In order to reflect the best available science and economics and not duplicate efforts, ARB should use these values in its economic analysis, subject to updates over time to continue reflecting the best available science and economics.

A. The federal social cost of carbon is based on rigorous and peer-reviewed science and economics[20]

The SC-CO_2 was developed with robust academic rigor, including peer review of the estimates underlying the models and other inputs used by the IWG. The SC-CO_2 values were developed using the three most widely cited climate economic impact models that link physical impacts to the economic damages of CO_2 emissions. All of these integrated assessment models—known as DICE, FUND, and PAGE[21]—have been extensively peer reviewed in the economic literature.[22] The newest versions of the models were also published in peer-reviewed literature.[23] Each model translates emissions into changes in atmospheric carbon concentrations, atmospheric concentrations into temperature changes, and temperature changes into economic damages.[24] The IWG gives each model equal weight in developing the SC-CO_2 values.[25] The IWG also used peer-reviewed inputs to run these models.[26] The IWG conducted an "extensive review of the literature . . . to select three sets of input parameters for these models: climate sensitivity, socio-economic and emissions trajectories, and discount rates."[27] For example, to derive socioeconomic and emissions pathways, the IWG used results from the Stanford Energy Modeling Forum, all of which were peer-reviewed, published, and publicly available.[28] For each parameter, the

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[18] Zero Zone, Inc. v. U.S. Dep't of Energy, Case No. 14-2147 (slip op. at 39-45) (7th Cir. Aug. 8, 2016) (attached as Exhibit D).
[19] *See* 2016 TSD ADDENDUM, *supra* note 8.
[20] This subsection and the following subsection are based on Policy Integrity's amicus brief to the Seventh Circuit Court of Appeals in Zero Zone, Inc. v. U.S. Dep't of Energy, Case No. 14-2147 (7th Cir. July 29, 2016) (attached as Exhibit E).
[21] More specifically: DICE (Dynamic Integrated Climate and Economy), developed by William Nordhaus (more information available at http://www.econ.yale.edu/~nordhaus/); PAGE (Policy Analysis of the Greenhouse Effect), developed by Chris Hope; and FUND (Climate Framework for Uncertainty, Negotiation, and Distribution), developed by Richard Tol (more information available at http://www.fund-model.org/). *See* 2010 TSD, *supra* note 11, at 5 n.2.
[22] *See* 2010 TSD, *supra* note 11, at 4-5.
[23] *See* 2016 TSD, *supra* note 8, at 6; *see also* William Nordhaus, *Estimates of the Social Cost of Carbon: Concepts and Results from the DICE-2013R Model and Alternative Approaches*, 1 J. ASS'N ENVTL. & RESOURCE ECONOMISTS 273 (2014).
[24] 2010 TSD, *supra* note 11, at 5.
[25] *Id* at 5.
[26] *Id.* at 5-29.
[27] *Id*. at 6.
[28] *Id*. at 15; *see also* Symposium, *International, U.S. and E.U. Climate Change Control Scenarios: Results from EMF 22*, 31 ENERGY ECON. S63 (2009).

IWG documented the inputs it used, all of which are based on peer-reviewed literature.[29] The analytical methods that the IWG applied to its inputs were also peer-reviewed, and the IWG's methods have been extensively discussed in academic journals.[30]

Throughout their development process, the federal SC-CO_2 estimates have been based on rigorous and peer-reviewed science and economics, making these values a good basis for thoughtful policy analysis, and indeed, the best available estimates of the economic costs of carbon dioxide emissions.

B. The social cost of carbon values were derived through a transparent and open interagency process that is designed to be updated over time to reflect new information

The IWG's analytical process in developing the SC-CO_2 was transparent and open, designed to solicit public comment and incorporate the most recent scientific analysis.

First, the process was transparent. Beginning in 2009, the Office of Management and Budget and the Council of Economic Advisers established the IWG, composed of scientific and economic experts from the White House, Environmental Protection Agency, and Departments of Agriculture, Commerce, Energy, Transportation, and Treasury, to develop a rigorous method of valuing carbon dioxide reductions resulting from regulations.[31] In February 2010, the IWG released estimated SC-CO_2 values, developed using the three most widely cited climate economic impact models (known as integrated assessment models). These models were each developed by outside experts, and published and extensively discussed in peer-reviewed literature.[32] An accompanying Technical Support Document released by the IWG discussed the models, their inputs, and the assumptions used in generating the SC-CO_2 estimates.[33] In May 2013, after all three underlying models had been updated and used in peer-reviewed literature, the IWG released revised SC-CO_2 values, with an accompanying Technical Support Document.[34] The U.S. Government Accountability Office examined the IWG's 2010 and 2013 processes, and found that these processes were consensus-based, relied on academic literature and modeling, disclosed relevant limitations, and incorporated new information via public comments and updated research.[35]

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[29] *See* 2010 TSD, *supra* note 11, at 12 to 23.
[30] *See, e.g.*, Michael Greenstone et al., *Developing a Social Cost of Carbon for U.S. Regulatory Analysis: A Methodology and Interpretation*, 7 REV. ENVTL. ECON. & POL'Y 23 (2013); Frank Ackerman & Elizabeth Stanton, *Climate Risks and Carbon Prices: Revising the Social Cost of Carbon*, ECON.: THE OPEN-ACCESS, OPEN-ASSESSMENT E-JOURNAL, Apr. 2012, at 6 (reviewing the IWG's methods and stating, "[T]he Working Group analysis is impressively thorough.").
[31] 2010 TSD, *supra* note 11, at 2-3.
[32] *See id.* at 12 to 23.
[33] *See generally id.*
[34] *See* 2013 TSD, *supra* note 12.
[35] GOV'T ACCOUNTABILITY OFFICE, REGULATORY IMPACT ANALYSIS: DEVELOPMENT OF SOCIAL COST OF CARBON ESTIMATES (2014).

The IWG requested that the National Academies of Sciences undertake a review of the latest research on modeling the economic aspects of climate change to help the IWG assess the technical merits and challenges of potential approaches for future updates to the SC-CO_2.[36] In mid-2016, the National Academies of Sciences issued an interim report to the IWG that recommended against conducting an update to the SC-CO_2 estimates in the near-term, but which included recommendations about enhancing the presentation and discussion of uncertainty regarding particular estimates.[37] The IWG responded to these recommendations in its most recent Technical Support Document from 2016,[38] which included an addendum on the SC-CH_4 and SC-N_2O.[39] The National Academies of Sciences are expected to issue a report sometime between December 2016 and February 2017 that will contain a roadmap for how SC-CO_2 estimates should be updated.[40]

The SC-CO_2 estimates will need to be updated over time to reflect the best-available science and changing economic conditions. ARB properly anticipates this possibility in its Discussion Draft, noting, "The State shall continue to monitor and engage in discussions related to any updates to U.S. EPA's SC-CO_2 methods and values."[41] If the federal government's estimates continue to reflect the best available science and economics, California should continue to use those values.

If the federal government's numbers are no longer updated to reflect the best available research, are no longer calculated based on a sound, transparent methodology that can be widely endorsed by economists, or are no longer consistent with other countries' estimates, California should undertake to update its own SC-CO_2 over time. In so doing, ARB should create an open and transparent process that involves reviewing the forthcoming National Academies of Sciences roadmap document, consulting with economists, considering peer-reviewed studies, and opening the process for public comment. The factors that California should consider in such an effort include the appropriate discount rate (discussed in section I.C. below), the extent of omitted damages (discussed in section I.C.), and the global nature of the damages associated with climate change.[42]

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[36] *See* 2016 TSD, *supra* note 8, at 2.
[37] NATIONAL ACADEMIES OF SCIENCES, ENGINEERING AND MEDICINE, ASSESSMENT OF APPROACHES TO UPDATING THE SOCIAL COST OF CARBON: PHASE 1 REPORT ON A NEAR-TERM UPDATE (2016) (attached as Exhibit F).
[38] 2016 TSD, *supra* note 8.
[39] 2016 TSD ADDENDUM, *supra* note 8.
[40] The National Academy of Sciences accepted public comment during its review process. Policy Integrity submitted comments during that process. Institute for Policy Integrity, Recommendations for Changes to the Final Phase 1 Report on the Social Cost of Carbon, and Recommendations in Anticipation of the Phase 2 Report on the Social Cost of Carbon (Apr. 29, 2016) [hereinafter "Policy Integrity NAS comments"] (attached as Exhibit G).
[41] Discussion Draft, *supra* note 3, at 114.
[42] The IWG and other commentators have concluded that the SC-CO_2 should reflect global climate damages for numerous reasons, including the global nature of the harm and the need to encourage international coordination to address climate change. *E.g.*, Peter Howard & Jason Schwartz, *Think Global: International Reciprocity as Justification for a Global Social Cost of Carbon* (Institute for Policy Integrity at NYU School of Law Working Paper, 2016) (forthcoming in COLUMBIA J. ENVTL. L.) (attached as Exhibit H); Michael Greenstone et al., *Developing a Social Cost of Carbon for U.S. Regulatory Analysis: A Methodology and Interpretation*, 7 REV. ENVTL. ECON. & POL'Y 23 (2013) (reviewing the policy justifications for a global value and the practical

At present, however, the federal SC-CO_2 values have been developed through an open and transparent process, with significant public input, using the best science and economic methods available. It is sensible for ARB to use the federal SC-CO_2, rather than developing its own social-cost values from the ground up.

C. California should consider the appropriate discount rate and extent of omitted damages in deciding which values to use for the social cost of carbon from within the range of federal values

The federal SC-CO_2 estimates are not a single number, but instead are a range of four estimates, based on three discount rates, plus a 95th percentile estimate.[43] Higher discount rates reduce the value of future streams of benefits, resulting in a lower SC-CO_2, as compared to lower discount rates. The discount rates used by the IWG are 5, 3, and 2.5 percent. The fourth value, which represents low-probability catastrophic situations, takes the 95th percentile of the SC-CO_2 from each model, using a 3-percent discount rate.[44]

The models used in calculating the SC-CO_2 estimate the damages resulting from the emission of a ton of carbon starting at the present time and continuing into the future, typically to the year 2300. The models then discount the value of those future damages over the entire timeframe, back to the present value, and add up the full effects over this time, to arrive at the SC-CO_2 figure.[45] The discount rate accounts for the fact that "[b]enefits or costs that occur sooner are generally more valuable."[46] The further in the future the effects are, the "more they should be discounted" before considering them in the cost-benefit analysis.[47]

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complications of a domestic-only value); Frank Ackerman & Elizabeth A. Stanton, *Climate Risks and Carbon Prices: Revising the Social Cost of Carbon,* 6 ECONOMICS E-JOURNAL 1 (2012)("The analysis by the federal Interagency Working Group is significant . . . for its recognition that policy should be based on global, rather than domestic, impacts."); Laurie Johnson & Chris Hope, *The Social Cost of Carbon in U.S. Regulatory Impact Analyses: an Introduction and Critique*, 2 J. ENVTL. STUD. SCI. 205, 208 (2012)("Empirical, theoretical, and ethical arguments strongly support the use of a global value."); William Pizer et al., *Using and Improving the Social Cost of Carbon*, 346 SCIENCE 1189, 1190 (2014) ("[T]he moral, ethical, and security issues . . . [and the] strategic foreign relations question . . . are compelling reasons to focus on a global SCC [social cost of carbon]."); Robert Kopp & Bryan Mignone, *Circumspection, Reciprocity, and Optimal Carbon Prices*, 120 CLIMATIC CHANGE 831, 831 (2013) ("[T]he domestically optimal price approaches the global cooperative optimum linearly with increasing circumspection and reciprocity"); Celine Guivarch, et al., *Letter: Social Cost of Carbon: Global Duty*, 351 SCIENCE 1160 (2016).

[43] 2010 TSD, *supra* note 11; 2013 TSD, *supra* note 12; 2016 TSD, *supra* note 8.

[44] *See* Environmental Defense Fund, Institute for Policy Integrity at New York University School of Law, Natural Resources Defense Council, and Union of Concerned Scientists, Comments on Proposed Exception to the Colorado Roadless Rule and Supplemental Draft Environmental Impact Statement 9-10 (Jan. 15, 2016) (describing the importance of the 95th percentile value), *available at* http://policyintegrity.org/documents/Forest_Service_SDEIS_comments.pdf.

[45] 2016 TSD, *supra* note 8.

[46] OFFICE OF MGMT. & BUDGET, CIRCULAR A-4 at 32 (2003) (laying out economic best practices for cost-benefit analysis) [hereinafter "CIRCULAR A-4"], *available at* https://www.whitehouse.gov/sites/default/files/omb/assets/omb/circulars/a004/a-4.pdf.

[47] *Id.*

Choosing the correct discount rate is crucial to obtaining the best SC-CO_2 estimate. Frequently, agencies will conduct their economic analyses using a range of SC-CO_2 values, reflecting the range of estimates.[48] Other analyses will focus on a "central" estimate of the SC-CO_2.[49] Frequently, the SC-CO_2 estimate using the 3-percent discount rate is considered to be the central estimate.[50] Some jurisdictions, like Washington State, have chosen to use a SC-CO_2 estimate based upon a 2.5-percent discount rate, due to the high level of uncertainty of forecasting climate change and its impacts.[51] Using a 2.5-percent rate as the basis for the estimate will result in a higher SC-CO_2 value than using a 3-percent discount rate.

A number of factors might result in a jurisdiction using a SC-CO_2 value that is higher than the estimate based on a 3-percent discount rate. Recent research has shown that the appropriate discount rate for intergenerational analysis may be even lower than that reflected in the SC-CO_2 analysis, which would result in a higher SC-CO_2.[52] A jurisdiction might decide that the uncertainty associated with climate damages warrants using a discount rate that declines over time, which would increase the SC-CO_2.[53] Furthermore, as ARB's Discussion Draft notes,[54] a number of types of damage from climate change are missing or poorly quantified in the federal SC-CO_2 estimates, meaning that the federal SC-CO_2 estimate associated with a 3-percent discount rate should be interpreted as a lower bound on the central estimate.[55] Omitted damages include the effects of climate change on fisheries; the effects of increased pest, disease, and fire pressures on agriculture and forests; and resource scarcity due to migration. Additionally, these models omit the effects of climate change on economic growth and the rise in the future value of environmental

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[48] *See, e.g.*, Energy Conservation Program: Energy Conservation Standards for Miscellaneous Refrigeration Products, 81 Fed. Reg. 75,194 (Oct. 26, 2016); Cross-State Air Pollution Rule Update for the 2008 Ozone NAAQS, 81 Fed. Reg. 74,504 (Oct. 26, 2016).

[49] *See, e.g.*, Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, Order Establishing the Benefit Cost Analysis Framework, New York Public Service Comm'n Case No. 14-M-0101 (Jan. 21, 2016) [hereinafter "BCA Order"].

[50] According to the 2010 TSD, the 3% discount rate estimate is considered the central estimate because it uses the central (i.e., middle) discount rate and is based on an average, rather than worse-than-expected, climate outcome; the average climate outcome is the standard assumption made by the IWG. 2010 TSD, *supra* note 11, at 25.

[51] WASHINGTON STATE DEPARTMENT OF COMMERCE, SOCIAL COST OF CARBON: WASHINGTON STATE ENERGY OFFICE RECOMMENDATION FOR STANDARDIZING THE SOCIAL COST OF CARBON WHEN USED FOR PUBLIC DECISION-MAKING PROCESSES 3-5 (2014).

[52] Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, New York Public Service Commission Case No. 14-M-0101, Institute for Policy Integrity Comments on Staff White Paper on Benefit-Cost Analysis in the Reforming Energy Vision Proceeding, Filing No. 447, at 8 (Aug. 21, 2015).

[53] *See* Martin L. Weitzman, *Gamma Discounting*, 91 AM. ECON. REV. 260, 270 (2001); Kenneth J. Arrow et al., *Determining Benefits and Costs for Future Generations*, 341 SCIENCE 349 (2013); Kenneth J. Arrow et al., *Should Governments Use a Declining Discount Rate in Project Analysis?*, 8 REV ENVTL. ECON. & POLICY 1 (2014); Maureen L. Cropper et al., *Declining Discount Rates*, 104 AM. ECON. REV. 538 (2014); Christian Gollier & Martin L. Weitzman, *How Should the Distant Future Be Discounted When Discount Rates Are Uncertain?* 107 ECONOMICS LETTERS 3 (2010). Policy Integrity further explores the use of declining discount rates in its recent comments to the National Academies of Sciences. Policy Integrity NAS Comments, *supra* note 40, at 13-16.

[54] Discussion Draft, *supra* note 3, at 113.

[55] *See* OMITTED DAMAGES, *supra* note 16; Richard L. Revesz et al., *Global Warming: Improve Economic Models of Climate Change*, 508 NATURE 173 (2014) (co-authored with Nobel laureate Kenneth Arrow).

services due to increased scarcity. Some of these omitted damages have particular relevance to California, including wildfires and agricultural damage. In the past few years alone, Californians have experienced severe drought and wildfires, which have threatened lives and livelihoods throughout the state.

California should weigh these factors, including the appropriate discount rate and omitted damages, in deciding which values to use for the SC-CO_2 out of the range of federal SC-CO_2 estimates, choosing a central value (or range of values resulting in a projection) that is at least as high as the $41 per ton value associated with a 3-percent discount rate.

D. California can draw support and lessons from other states that use the federal social cost of carbon in their rulemaking

It may be helpful for ARB to understand how other states' agencies have used the SC-CO_2, in order to decide how to structure its own approach. Leading states, including Minnesota, Maine, New York and Washington have all begun using the federal SC-CO_2 in energy-related cost-benefit analysis, recognizing that the SC-CO_2 is the best available estimate of the marginal economic impact of carbon emission reductions.[56] Several states and municipalities have used the SC-CO_2 in the context of renewable energy decisionmaking, and New York State has used the SC-CO_2 to assess the value of keeping some of the state's nuclear power plants operational.

Minnesota

Minnesota Statute 216B.2422, subdivision 3 states, "The [Public Utilities] commission shall, to the extent practicable, quantify and establish a range of environmental costs associated with each method of electricity generation. A utility shall use the values established by the commission in conjunction with other external factors, including socioeconomic costs, when evaluating and selecting resource options in all proceedings before the commission, including resource plan and certificate of need proceedings."[57] Between 1993, when 216B.2422 was enacted, and 2014, Minnesota used its own methodology to determine the costs of $PM_{2.5}$, SO_2, NO_x, and CO_2.[58] In 2014, after environmental advocacy groups filed a motion requesting that the Minnesota Public Utility Commission update these figures, the commission referred the issue to the Office of Administrative Hearings to assess whether the state should use the federal SC-CO_2 and how to value externalities.[59]

The Administrative Judge who reviewed the matter of the Further Investigation into Environmental and Socioeconomic Costs Under Minnesota Statutes Section 216B.2422,

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[56] *See* Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, New York Public Service Commission Case No. 14-M-0101, Institute for Policy Integrity Comments on Staff White Paper on Benefit-Cost Analysis in the Reforming Energy Vision Proceeding, Filing No. 447, at 22 (Aug. 21, 2015).

[57] 2016 Minnesota Stat. § 216B.2422 subd. 3.

[58] State of Minnesota, Office of Administrative Hearings, *In the Matter of the Further Investigation into Environmental and Socioeconomic Costs Under Minnesota Statutes Section 216B.2422, Subdivision 3*, Docket No. OAH 80-2500-31888, MPUC E-999/CI-14-643, Findings of Fact, Conclusions, and Recommendations: Carbon Dioxide Values 2-3 (Apr. 15, 2016).

[59] *Id* at 4.

Subdivision 3 recommended that "the Commission adopt the Federal Social Cost of Carbon as reasonable and the best available measure to determine the environmental cost of CO_2, establishing a range of values including the 2.5 percent, 3.0 percent, and 5 percent discount rates . . . ."[60]

Maine[61]

Maine enacted the Act to Support Solar Energy Development in Maine during its 2014 legislative session.[62] Section 1 of the Act states that it is "in the public interest is to develop renewable energy resources, including solar energy, in a manner that protects and improves the health and well-being of the citizens and natural environment of the State while also providing economic benefits to communities, ratepayers and the overall economy of the State."[63] Section 2 of the Act instructs the Public Utilities Commission to determine the value of distributed solar energy generation in the State, evaluate implementation options, and deliver a report to the Legislature. Maine has a statute that calls for calculating "the societal value of the reduced environmental impacts of the energy."[64] Maine uses the federal SC-CO_2, as well as other monetized costs and benefits, to make this calculation. Because carbon costs are already partially embedded in existing energy valuation because of carbon emissions caps under the Regional Greenhouse Gas Initiative ("RGGI"), the net SC-CO_2 is calculated by subtracting the embedded carbon allowance costs from the total SC-CO_2. The Maine Public Utilities Commission uses the federal SC-CO_2, with a central 3-percent discount rate estimate.

Similar to California's AB 32, Maine's statute requires the PUC to assess how to maximize social welfare in its policy options. Maine addresses this requirement by weighing market costs and benefits with the monetized values of societal benefits in a cost-benefit analysis.[65]

New York

New York's Clean Energy Standard and accompanying Zero Emissions Credit ("ZEC") take into account the SC-CO_2 in calculating the value of using emission-free nuclear power, rather than carbon-emitting fossil fuel power. The New York Public Service Commission's program is designed to compensate nuclear plants based directly on the value of the carbon-free attributes of their generation.[66]

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[60] *Id.* at 123.
[61] For more details, see Maine Public Utilities Commission, Maine Distributed Solar Valuation Study (2015) [hereinafter "MPUC Distributed Solar Valuation Study"], *available at* http://www.maine.gov/mpuc/electricity/elect_generation/documents/MainePUCVOS-FullRevisedReport_4_15_15.pdf .
[62] Maine P.L ch. 562 (Apr. 24, 2014) (codified at 35-A M.R.S.A. §§ 3471-3474).
[63] *Id* at § 3472(1).
[64] *Id.* at § 2(1).
[65] MPUC Distributed Solar Valuation Study at 4.
[66] Denise Grab & Burcin Unel, New York's Clean Energy Standard Is a Key Step Toward Pricing Carbon Pollution Fairly, UTILITY DIVE (Aug.18, 2016), *available at* http://www.utilitydive.com/news/new-yorks-clean-energy-standard-is-a-key-step-toward-pricing-carbon-pollut/424741/.

The commission recognized that the federal SC-CO_2 is the "best available estimate of the marginal external damage of carbon emissions."[67] It then designed the ZEC based upon the difference between the average April 2017 through March 2019 projected SC-CO_2, as published by the IWG in July 2015 and a fixed baseline portion of the cost that is already captured in the market revenues received by the eligible nuclear facilities under RGGI.[68] The New York Public Service Commission uses the federal SC-CO_2, with a central 3-percent discount rate estimate.[69]

Washington

Executive Order 14-04 on Washington Carbon Pollution Reduction and Clear Energy Action requires the state's agencies to "[e]nsure the cost-benefit tests for energy-efficiency improvements include full accounting for the external cost of greenhouse gas emissions."[70] With these requirements in mind, the Washington State Energy Office, in consultation with the Washington State Department of Ecology, recommended that all state agencies use the federal SC-CO_2 estimates.

The Energy Office noted that the federal SC-CO_2 estimates do not capture the total cost of emitting carbon dioxide into the atmosphere (total future climate damages), and because of omitted damages and uncertainty about the full scope of the consequences of climate change, the Office recommended using the lower 2.5-percent discount rate.[71]

The Energy Office supports using the 2.5-percent discount rate for a number of reasons.[72] First, the 2.5-percent discount most closely matches with the existing Office of Financial Management real discount rate of 0.9 percent. Second, the IWG models focus only on the damages of climate change that can be easily monetized and since the trend seems to be that additional impacts are monetized with each federal SC-CO_2 update, Washington can stay ahead of this trend by choosing the lowest IWG discount rate. Third, because the discount rate applied to greenhouse gas emissions is an "intergenerational" discount rate applied to society as a whole, the discount rate used in this context should be substantially lower than private sector discount rates. Fourth, there is a higher risk associated with underestimating the SC-CO_2 than with overestimating it. Fifth, Washington State wants to lead on climate issues, so it makes sense for the Energy Office to put forth the higher associated SC-CO_2.

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[67] Proceeding on Motion of the Commission to Implement a Large-Scale Renewable Program and a Clean Energy Standard, New York Public Service Comm'n Case No. 15-E-0302, Order Establishing a Clean Energy Standard 131, (Aug. 1, 2016).
[68] *Id.* at 129.
[69] BCA Order, *supra* note 49, at appx. C.
[70] State of Washington, Executive Order 14-04 at 6, *available at* http://www.governor.wa.gov/sites/default/files/exe_order/eo_14-04.pdf.
[71] WASHINGTON STATE DEPARTMENT OF COMMERCE, SOCIAL COST OF CARBON: WASHINGTON STATE ENERGY OFFICE RECOMMENDATION FOR STANDARDIZING THE SOCIAL COST OF CARBON WHEN USED FOR PUBLIC DECISION-MAKING PROCESSES 3 (2014).
[72] *Id.* at 3-5.

Washington state agencies have begun following the recommendation of the state's energy office and using a 2.5-percent discount rate for their economic analyses involving greenhouse gas emissions.[73]

Washington and the other states' experiences in applying the federal SC-CO_2 can be instructive for California's ARB as it decides how to integrate the "social costs of the emissions of greenhouse gases" into its decisionmaking.

E. How ARB should use the social cost of carbon

Once ARB has selected a value to use for the SC-CO_2 (or SC-CH_4 or SC-N_2O), it can use those figures to calculate the expected monetized benefits of avoided emissions. In order to conduct this analysis properly, it is necessary to understand how timing factors into the analysis of the social cost of greenhouse gases.

Timing plays into the economic analysis surrounding the SC-CO_2 in at least three ways. First, as discussed in Section I.C, the values of the SC-CO_2 in the IWG analysis were calculated by adding up the streams of future effects from a ton of emissions in the year of anticipated release, with discount rates reflecting the passage of time between the anticipated release and the future effects.

Second, the federal SC-CO_2 values that have come out of that process represent the damages associated with each additional ton of carbon dioxide emissions released *from the perspective of the year of emission*. Thus, it is necessary when conducting a policy analysis *at the present time* about policies that affect greenhouse gas releases *in the future* to make sure that the SC-CO_2 values are translated into the *perspective of the year of the policy decision*. The proper way to accomplish this translation is by using the discount rate to convert the effects of emissions from the year of release into the present value.

Third, entirely separate from the discounting considerations, which reflect the resource tradeoffs facing the actors in the relevant year of action, currency tends to inflate over time. The IWG's calculations for the SC-CO_2 are based upon 2007 dollars, but the purchasing power of the dollar has gone down since then, meaning that $1 in 2007 is worth $1.16 in 2016.[74] It is important to ensure that the analysis is consistent across time frames and makes sense to decisionmakers. Thus, before any calculations are done, the analysts should account for inflation by converting all of the SC-CO_2 values from 2007 dollars into dollars for the year the analysis is taking place (currently, 2016).

Understanding these timing considerations, once ARB has selected a value to use for the SC-CO_2 (or SC-CH_4 or SC-N_2O), it can use those figures to calculate the expected monetized benefits of avoided emissions. To make this calculation, the SC-CO_2 figure should be

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[73] *See, e.g.*, STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, PRELIMINARY COST-BENEFIT AND LEAST-BURDENSOME ALTERNATIVE ANALYSIS: CHAPTER 173-442 WAC CLEAN AIR RULE & CHAPTER 173-441 WAC REPORTING OF EMISSIONS OF GREENHOUSE GASES 38 (2016), *available at* https://fortress.wa.gov/ecy/publications/documents/1602008.pdf.

[74] *See* CPI Inflation Calculator, http://data.bls.gov/cgi-bin/cpicalc.pl?cost1=1&year1=2007&year2=2016

multiplied by the projected avoided emissions to provide a figure for the monetized benefits of the scoping plan's avoided greenhouse gas emissions. ARB can look to federal rulemakings for guidance on how to conduct this analysis.[75] Specifically, ARB should:

1. Convert the SC-CO_2 values from 2007 dollars to the year of analysis, using a consumer price index inflation calculator[76] (if the values have not yet been converted);
2. Determine the avoided emissions for each Year X between the plan's effective date and the plan's end date of 2030;
3. Multiply the quantity of avoided emissions in Year X by the corresponding SC-CO_2 (or SC-CH_4 or SC-N_2O) in Year X,[77] to calculate the monetary value of damages avoided by avoiding emissions in Year X ;[78]
4. Apply the same discount rate used to calculate the SC-CO_2 to calculate the present value of future effects of emissions from Year X;[79]
5. Sum these values for all relevant years between the plan's effective date and the plan's end date of 2030 to arrive at the total monetized climate benefits of the plan's avoided emissions;[80] and
6. Qualitatively describe in the final discussion of the climate benefits all of the other damages that have been omitted from the SC-CO_2.

The ARB could conduct these calculations with a single, central discount rate for the SC-CO_2, or the agency could conduct the analysis several times, using a range of discount rates for the SC-CO_2, being sure to use the selected discount rate in step 4 for each different iteration.

[75] *See, e.g.*, Energy Conservation Program: Energy Conservation Standards for Commercial Refrigeration Equipment 79 Fed. Reg. 17,726, at 17,728, 17,773, 17,779, 17,811 (Mar. 28, 2014); U.S. DEPARTMENT OF ENERGY, TECHNICAL SUPPORT DOCUMENT: ENERGY EFFICIENCY PROGRAM FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT 12-22, 13-4 to 13-5, 14-2 (2014).

[76] *See* CPI Inflation Calculator, http://data.bls.gov/cgi-bin/cpicalc.pl

[77] In general, the SC-CO_2 goes up over time because greenhouse gases accumulate, exacerbating the effects of climate change—and therefore the harm from each additional unit of emissions—over time. 2010 TSD, *supra* note 11, at 28.

[78] The SC-CO_2 for a given year encompasses the effects that a ton of carbon dioxide, once emitted in that year, will have stretching into the future over a 300-year time frame. 2010 TSD, *supra* note 11, at 25.

[79] Using a consistent discount rate for both the SC-CO_2 (assessed from the perspective of the actors in the year of emission) and the net present value calculation (assessed from the perspective of the decisionmaker) is important to ensure that the decisionmaker is treating emissions in each time frame similarly. The decisionmaker should not be overvaluing or undervaluing emissions in the present as compared to emissions in the future. NATIONAL ACADEMIES OF SCIENCES, ENGINEERING AND MEDICINE, ASSESSMENT OF APPROACHES TO UPDATING THE SOCIAL COST OF CARBON: PHASE 1 REPORT ON A NEAR-TERM UPDATE 49-50 (2016).

[80] Steps 4 and 5 combined are equivalent to calculating the present value of the stream of future monetary values using the same discount rate as the SC-CO_2 discount rate.

F. ARB should also use the best available estimates of the social cost of methane, the social cost of nitrous oxide, and, as they are developed, the social costs of other greenhouse gases

The IWG has also developed robust federal estimates of the social cost of methane and social cost of nitrous oxide. EPA has used the IWG's estimates for the federal SC-CH_4, but has not yet found an occasion to use the SC-N_2O.[81] California should use these federal SC-CH_4 and SC-N_2O estimates in its economic analyses when these gases are being regulated.

The SC-CH_4 and SC-N_2O methodologies build directly on the SC-CO_2 methodology. Therefore, the same rigorous, consensus-based, transparent process used for the federal SC-CO_2 has shaped the federal SC-CH_4 and federal SC-N_2O estimates. Like the SC-CO_2, the SC-CH_4's emphasis on a global value and selection of discount rates is justified, and if anything the SC-CH_4 is underestimated due to conservative assumptions.

EPA first developed SC-CH_4 estimates based upon a recent peer-reviewed article: Marten et al.[82] The IWG has now similarly endorsed the Marten et al. approach.[83] Marten et al. takes a reasonable (although conservative) approach to estimating the SC-CH_4 and currently constitutes "the best available science" to inform agency regulation. The Marten et al. study maintains the same three integrated assessment models, five socioeconomic-emissions scenarios, equilibrium climate sensitivity distribution, three constant discount rates, and aggregation approach that were agreed upon by the IWG. Consequently, many of the key assumptions underlying the federal SC-CH_4 estimates have already gone through a transparent, consensus-driven, publically reviewed, regularly updated process, as they were borrowed from the IWG's thoroughly vetted methodology.

The IWG's SC-CH_4 and SC-N_2O estimates improve upon an approach that simply adjusts the SC-CO_2 by these other gases' warming potentials because these gas-specific estimates take into account specific characteristics of the gases involved, making the estimates more accurate. For example, the federal SC-CH_4 estimates directly account for the quicker time horizon of methane's effects compared to carbon dioxide, include the indirect effects of methane on radiative forcing, and reflect the complex, nonlinear linkages along the pathway from methane emissions to monetized damages.

Just as the federal SC-CO_2 likely underestimates the true social cost of carbon, the federal SC-CH_4 and SC-N_2O are likely to underestimate the true social cost of methane due to omitted damages and uncertainties regarding the appropriateness of the model.[84]

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[81] *See* Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources, 81 Fed. Reg. 35,823 (June 3, 2016); Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. 59,331 (Aug. 29, 2016); Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 81 Fed. Reg. 59,275 (Aug. 29, 2016).

[82] Alex L. Marten et al., *Incremental CH_4 and N_2O Mitigation Benefits Consistent With the US Government's SC-CO_2 Estimates*, 15 CLIMATE POLICY 272 (2014).

[83] 2016 TSD ADDENDUM, *supra* note 8.

[84] Alex L. Marten et al., *Incremental CH_4 and N_2O Mitigation Benefits Consistent with the U.S. Government's SC-CO_2 Estimates*, 15 CLIMATE POLICY 272, 277, 292 (2014); Joint SC-CO_2 Comments, *supra* note 5, at 19-20.

Nonetheless, the federal SC-CH_4 and SC-N_2O are the best available estimates of the social costs associated with the emission of one ton of each of these greenhouse gases.

II. ARB should conduct both cost-effectiveness analysis and cost-benefit analysis, in order to satisfy its new statutory requirements

ARB has traditionally used cost-effectiveness analysis for its emissions reduction programs, although the statutory language warrants the agency's use of cost-benefit analysis in addition to cost-effectiveness analysis. AB 32 specifies that "[t]he regulations adopted by the state board pursuant to this section shall achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions from those sources or categories of sources, in furtherance of achieving the statewide greenhouse gas emissions limit."[85] The act defines "cost-effective" as "the cost per unit of reduced emissions of greenhouse gases adjusted for its global warming potential."[86]

Courts have interpreted ARB's authority to interpret this language broadly, but not without limit. In *Association of Irritated Residents v. California Air Resources Board*, the plaintiffs argued that ARB's economic analysis in the 2008 scoping plan was inadequate because, among other factors, it did not create and apply a standard criteria for cost-effectiveness and did not directly compare the environmental and public health effects of different possible measures for compliance. The court refused to strike down the scoping plan on these grounds. Part of the court's holding relied on the agency's assertion that "[t]he limitations of the available modeling tools . . . prevent a comparison between market-based approaches and alternative strategies, such as one that relies only on direct regulation," as well as the fact that the statute at that time did not require comparison of the effects of individual measures, but only of the whole plan.[87] The court deferred to the agency in part because "[d]etermining the best means of identifying and implementing the most cost-effective and feasible measures to maximize greenhouse gas emissions reductions involves numerous highly technical and novel scientific, technical and economic issues."[88]

However, both the statute and the availability of additional modeling techniques have changed since the AB 32 plan was proposed. The statute now explicitly calls for the agency to identify the pollution and health effects of each proposed emission reduction measure.[89] And the economic models used to monetize pollution effects have grown ever more robust. EPA has developed a thorough and standardized method for monetizing the benefits of a whole range of pollutants, including particulate matter, NOx, SO_2, and ozone. In light of these changes since *AIR* was decided, ARB should conduct a thorough, monetized analysis of the full range of significant externalities associated with the compliance alternatives.

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[85] Cal. Health & Safety Code § 38560.
[86] Cal. Health & Safety Code § 38505(d).
[87] Ass'n of Irritated Residents v. State Air Resources Bd., 206 Cal. App. 4th 1487, 1501 (2012).
[88] *Id.* at 1502.
[89] Cal. Health & Safety Code § 38562.7.

A. ARB should use a cost-benefit analysis, in addition to its traditional cost-effectiveness analysis, in order to meet the mandate set out in AB 197

AB 197 instructs ARB to "consider the social cost of the emissions of greenhouse gases" in future emissions reduction rules.[90] While ARB has conducted cost-effectiveness and other economic analyses in the past,[91] it should use a cost-benefit analysis for comparing combinations of possible compliance mechanisms, as set out in California Health & Safety Code section 38562.7. That section reads:

> Each scoping plan update developed pursuant to Section 38561 shall identify for each emissions reduction measure, including each alternative compliance mechanism, market-based compliance mechanism, and potential monetary and nonmonetary incentive the following information:
>
> (a) The range of projected greenhouse gas emissions reductions that result from the measure.
>
> (b) The range of projected air pollution reductions that result from the measure.
>
> (c) The cost-effectiveness, including avoided social costs, of the measure.

The advantages of cost-benefit analysis as compared to cost-effectiveness analysis alone are detailed below. While ARB is still required to conduct cost-effectiveness analysis of proposed measures,[92] using cost-benefit analysis to quantify and monetize the benefits of each proposed alternative in the new scoping plan will allow the ARB to best fulfill the mandate set out in section 38562.7. Monetizing, or pricing, benefits is important because it is the most effective way to aggregate information (in this case, the costs and benefits), and determine how to allocate scarce resources to produce the greatest societal benefit.[93]

B. Cost-benefit analysis is better than cost-effectiveness analysis for maximizing social welfare

In accordance with statutory requirements, ARB conducted cost-effectiveness analysis for the rules and regulations it promulgated under AB 32. There are a number of reasons why ARB should use cost-benefit analysis in addition to cost-effectiveness analysis in order to fulfill its statutory mandate, as revised under AB 197.

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[90] Cal. Health & Safety Code § 38562.5.

[91] *See* CALIFORNIA AIR RESOURCES BOARD, CLIMATE CHANGE SCOPING PLAN: A FRAMEWORK FOR CHANGE 84-85 (2008); *see generally* CALIFORNIA AIR RESOURCES BOARD, UPDATED ECONOMIC ANALYSIS OF CALIFORNIA'S CLIMATE CHANGE SCOPING PLAN: STAFF REPORT TO THE AIR RESOURCES BOARD (Mar. 24, 2010).

[92] Cal. Health & Safety Code § 38562.5.

[93] RICHARD L. REVESZ & MICHAEL A. LIVERMORE, RETAKING RATIONALITY: HOW COST-BENEFIT ANALYSIS CAN BETTER PROTECT THE ENVIRONMENT AND OUR HEALTH 13 (2008).

A cost-effectiveness analysis assesses how to achieve a given policy goal most cheaply and does not allow for easy comparison of distinct policy options that provide multiple types of benefits to society.[94] In contrast, cost-benefit analysis assesses a number of potential policy options to determine which combination of the options will result in the greatest net benefits (that is, total benefits, minus total costs) to society, including producers, consumers, and third parties.[95] Cost-benefit analysis allows regulators to select the most effective policy options in a resource-constrained world.

Cost-benefit analysis is a systematic method of calculating and comparing the costs and benefits of different policy approaches, in order to choose the option that maximizes net benefits for society. A cost-benefit analysis involves several steps. First, decisionmakers identify costs and benefits associated with each policy alternative. Because the goal is to select the alternative that maximizes net social welfare, it is essential to account for any costs or benefits that could affect the ultimate decision, including any externalities.[96] An externality is the uncompensated benefit or cost imposed on third parties by a transaction: in other words, an effect whose cost or benefit is not internalized by the acting party. Pollution, like the hazardous chemicals and particulate matter released from power plants or refineries, is one classic example of an externality.[97] Once all significant impacts are cataloged, analysts quantify, and then monetize each effect, to the extent possible, using a common metric (like dollars) to allow comparison between various policies.[98] Established economic methodologies exist for weighing various effects, including impacts to health, safety, and the environment.[99] Once all effects are translated to a common metric, the analyst subtracts costs from benefits to find the net benefits of each approach. The decisionmaker can then select the policy options that generate the greatest net benefits to society.[100] Because cost-benefit analysis involves a detailed assessment of the anticipated outcomes of alternatives, it also assists decisionmakers in communicating to the public and stakeholders why a particular outcome was selected.

In its cost-benefit analysis, ARB should take into account the significant indirect benefits, also known as ancillary or co-benefits, of regulating greenhouse gas emissions. Co-benefits of greenhouse gas regulation include reductions of other pollutants that occur together with greenhouse gases, including criteria pollutants, like particulate matter, and air toxics. Reducing these co-pollutants may improve air quality and lessen some of the adverse public health consequences of air pollution. Consideration of ancillary consequences of ARB's rulemaking is consistent with the statutory mandate set out in AB 32 which tasks ARB with designing greenhouse gas emissions reduction measures that maximize "additional environmental and economic co-benefits for California, and complements the

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[94] *See* CIRCULAR A-4, *supra* note 46, at 9-12. *See also* Denise A. Grab, *Balancing on the Grid Edge: Regulating for Economic Efficiency in the Wake of* FERC v. EPSA, 40 HARV. ENVTL. L. REV. F. 32, 36 (2016).
[95] CIRCULAR A-4, *supra* note 46, at 9-12.
[96] *Id.* at 2-3.
[97] *Cf. id*. at 4.
[98] Where quantification is not possible, the analysis should describe the likely effects qualitatively, and the decisionmaker should still consider those factors in her analysis.
[99] *See* CIRCULAR A-4, *supra* note 46, at 18-26.
[100] Decisionmakers may also balance economic efficiency with other goals, like distributional fairness.

state's efforts to improve air quality."[101] Consideration of co-benefits is also consistent with AB 197, which requires ARB to identify both the "range of projected greenhouse gas emissions reductions that result from the measure" and the "range of projected air pollution reductions that result from the measure."[102] Using comprehensive cost-benefit analysis that accounts for the monetized value of co-benefits enhances ARB's ability to determine which policy options would maximize social welfare. ARB notes that the SC-CO_2 is incomplete because it "does not account for impacts related to changes in criteria pollutants or toxics resulting from GHG focused policies and programs."[103] ARB should address this weakness by using cost-benefit analysis to weigh co-benefits in its economic analysis.

Cost-benefit analysis is the most effective way to fulfill ARB's mandate to "[d]esign the regulations . . . in a manner that . . . seeks to minimize costs and maximize the total benefits to California"[104] and also to "[c]onsider overall societal benefits, including reductions in other air pollutants, diversification of energy sources, and other benefits to the economy, environment, and public health."[105] Without understanding the full range of benefits and costs, it will be difficult, if not impossible, for ARB to appropriately consider overall societal benefits and to maximize benefits (minus costs) to California.

Furthermore, a cost-benefit analysis that quantifies and monetizes, to the extent feasible, the health benefits associated with co-benefit reductions associated with different combinations of emission reduction measures will help decisionmakers and communities to understand the full scope of the effects of pollution that can be avoided under different reduction approaches. In order to "consider the social costs of the emissions of greenhouse gases" and to "prioritize . . . [e]mission reduction rules and regulations that result in direct reductions,"[106] it will be necessary to understand the true extent and impact of those direct reductions. Without quantifying and monetizing these co-benefits in a comprehensive cost-benefit analysis, there is a risk that these co-benefits might be undervalued, especially if a dollar value is put on the greenhouse gas reductions through the requirement to consider the social costs of the greenhouse gas emissions. The same argument applies to the requirement for the scoping plans to identify for each possible compliance measure the range of projected greenhouse gas emission reductions, the range of projected air pollution reductions, and the cost effectiveness, including avoided social costs.[107] To monetize the greenhouse gas reductions with an avoided social cost analysis, without also monetizing the projected air pollution reductions, would undervalue the co-benefits from the air pollution reductions. Cost-benefit analysis can also aid ARB in transparently communicating the significant effects of their policy decisions to the public, by laying out their full anticipated economic effects.

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[101] Cal Health & Safety Code § 38501(h).
[102] Cal Health & Safety Code § 38562.7.
[103] Discussion Draft, *supra* note 3, at 113.
[104] Cal. Health & Safety Code § 38562(b)(1).
[105] Cal Health & Safety Code § 38562(b)(6).
[106] Cal. Health & Safety Code § 38562.5.
[107] Cal. Health & Safety Code § 38562.7.

California can look to EPA's regulatory impact analyses to see how co-benefits have been monetized and used in cost-benefit analysis. For example, in the Clean Power Plan Final Rule regulatory impact analysis, EPA monetized societal costs and benefits such as lost work days, acute bronchitis, emergency room visits for cardiovascular effects and premature mortality based on short-term study estimates.[108] EPA's estimate of the monetized co-benefits is based on the best available science and methods and is supported by the Sciences and Advisory Board of the EPA, as well as the National Academy of Sciences.

In addition to helping ARB fulfill its statutory requirements, conducting comprehensive cost-benefit analysis that includes externalities, like pollutants affecting public health, is also consistent with California's standardized regulatory impact assessment requirements. The Department of Finance's regulations indicate that, when conducting economic impact assessments, agencies must "produce (to the extent possible) quantitative estimates of . . . [t]he benefits of the regulations, including but not limited to benefits to the health, safety, and welfare of California residents, worker safety, and the state's environment and quality of life, among any other benefits identified by the agency."[109]

In contrast to a cost-benefit analysis, the cost-effectiveness analysis historically used in California's greenhouse gas emission reduction decisions is less comprehensive in its assessment of effects, fails to compare alternatives in a way that is useful for prioritizing actions with the greatest net benefits, and cannot communicate information to the public as fully or as transparently. For example, in the 2008 initial AB 32 Scoping Plan, ARB set forth both costs and benefits of proposed greenhouse gas emissions reduction programs, but failed to monetize societal benefits in such a way that they could be directly compared to costs. In evaluating AB 32 and its subsequent regulations, ARB used a cost-effectiveness approach, as the board understood it to be required under the statute. This approach placed the focus on the costs of proposed measures to energy suppliers, other businesses, their customers, and to California's economy at-large but in doing so, did not fully monetize social externalities, including co-benefits. Cost-benefit analysis is the most analytically sound way to choose among policy options in a resource-limited world.

Should ARB choose to explore reductions beyond those that are mandated in the new 2030 targets, it should use cost-benefit analysis. Cost-benefit analysis is most effective when it can also be used to set the stringency of the standard, in addition to the selection of policy approaches to achieve the goal. While the scoping plan adopts a 40 percent reduction below 1990 levels by 2030 as the minimum target in all three of the alternative reduction measures, ARB may have the option to reduce greenhouse gases even further.[110] If considering further reductions is a possibility, ARB should use cost-benefit analysis to guide the setting of such targets.

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[108] U.S. ENVIRONMENTAL PROTECTION AGENCY, REGULATORY IMPACT ANALYSIS FOR THE CLEAN POWER PLAN FINAL RULE tbl.ES-6 at ES-12 to ES-14 (2016).

[109] 1 Cal. Code Reg. § 2003(a)(3)(F).

[110] Cal. Health & Safety Code § 38566 ("[T]he state board shall ensure that statewide greenhouse gas emissions are reduced to **at least** 40 percent below the statewide greenhouse gas emissions limit no later than December 31, 2030." (emphasis added)).

If ARB chooses to simply meet the minimum 2030 targets with the measures laid out in the proposed scoping plan, then the reduction in greenhouse gases will be consistent across different alternative scenarios (a total of 40% below 1990 levels by 2030), which means that the social value of greenhouse gas reductions are likely to remain consistent between alternatives (possibly with some variation if the makeup of the mixture of greenhouse gases reduced changes among alternatives). It is nonetheless important to use the SC-CO_2, SC-CH_4, and/or SC-N_2O in the cost-benefit analysis so that all of the costs and benefits associated with each proposed measure are transparent to the public. However, most of the difference in net benefits between the different alternatives will stem from differences in co-benefit reductions, as well as compliance costs. Once the analysis is complete, ARB will be able to determine which of the alternative compliance scenarios results in the greatest net benefits to society, and will be able to use that information in conjunction with other statutory requirements to select the optimal combination of reduction measures.

Conclusion

In brief, ARB should use the federal SC-CO_2 and SC-CH_4 based on the best available science as the value of the social cost of greenhouse gases to fulfill its mandate under AB 197. Furthermore, California should use cost-benefit analysis to evaluate policy alternatives in order to ensure that it maximizes the benefits to society of the updated program.

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