BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF PUBLIC SERVICE	**)**	
COMPANY OF NEW MEXICO'S	**)**	
ABANDONMENT OF SAN JUAN	**)**	**Case No. 19-00018-UT**
GENERATING STATION UNITS 1 AND 4	**)**	
	)	

DIRECT TESTIMONY

OF

JASON A. SCHWARTZ

ON BEHALF OF

COALITION FOR CLEAN AFFORDABLE ENERGY

SAN JUAN CITIZEN'S ALLIANCE

DINÉ CITIZENS AGAINST RUINING OUR ENVIRONMENT

October 18, 2019

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JASON A. SCHWARTZ

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INTRODUCTION, PURPOSE, AND QUALIFICATIONS

Q: PLEASE STATE YOUR NAME, POSITION, AND BUSINESS ADDRESS.

A: My name is Jason A. Schwartz. I am an adjunct professor and the Legal Director of the Institute for Policy Integrity at New York University School of Law.[1] Policy Integrity's address is 139 MacDougal Street, Wilf Hall, 3rd Floor, New York, NY 10012. 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.

Q: WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A: My testimony—which I prepared along with my colleague, Denise A. Grab—applies a widely-accepted economic methodology, known as the Social Cost of Carbon, to monetize the climate benefits of retiring the coal-fired San Juan Generating Station Units 1 and 4. Specifically, retiring the coal-fired units will deliver *billions of dollars* of real-world, global climate benefits to agricultural productivity, property values, human health, and other climate-vulnerable market and nonmarket sectors. The precise net value depends on the replacement portfolio selected. The testimony further argues that the New Mexico Public Regulation Commission has the legal responsibility to fully weigh environmental externalities in its decisions about energy resources, and that using the social cost of carbon to translate climate impacts into the common metric of dollars is the best way for the Commission to ensure that environmental effects are fairly weighed against other costs and benefits, as well as to communicate the benefits of its energy policy decisions to the public.

[1] No part of this testimony purports to present the views, if any, of New York University or its School of Law.

Q: WHAT ARE YOUR PROFESSIONAL QUALIFICATIONS?

A: I received my law degree from New York University in 2006. I am admitted to the bars of the Supreme Court of the United States, the U.S. Courts of Appeals for the Second, Ninth, Tenth, and D.C. Circuits, the U.S. District Court of Colorado, and the Commonwealth of Virginia; my application to the bar for the State of Colorado is pending. I have taught as an adjunct professor at New York University School of Law since 2013, and I have been the Legal Director of the Institute for Policy Integrity since 2011. In that position, I have provided testimony and comments on states' use of the social cost of greenhouse gases in energy planning decisions to the Colorado Public Utilities Commission, the Colorado legislature, the Virginia State Corporation Commission, and the New York State Public Service Commission. I have also submitted expert testimony to the Colorado Air Quality Control Commission calculating the climate benefits of vehicle emission standards using the social cost of greenhouse gas metrics.

I co-authored this testimony with my colleague, Denise A. Grab. She is an adjunct professor at New York University School of Law and the Western Regional Director of the Institute for Policy Integrity. She has provided testimony and comments on states' use of the social cost of greenhouse gases in energy planning decisions to the Nevada Public Utilities Commission, the California Public Utilities Commission, the New York Public Service Commission, the New Jersey legislature, and other state entities.

SUMMARY OF FINDINGS

Q: PLEASE SUMMARIZE YOUR FINDINGS.

A: By applying a widely-accepted economic methodology, known as the Social Cost of Carbon, to monetize the climate benefits of retiring the coal-fired San Juan Generating Station Units 1 and 4, this testimony estimates that the total avoided social costs—or, conversely, the social benefits—of retiring the San Juan coal units and reducing their carbon dioxide emissions will be several billion dollars. Depending on the replacement portfolio, the net present value of climate benefits would be over $1.5 billion using the Interagency Working Group's central estimate of the social cost of carbon, or over $4.8 billion using the high-impact estimates (over a 17-year emission forecast period, from 2022-2038). These figures represent the benefits of avoiding the global, social externalities of carbon dioxide emissions from the San Juan coal units, in terms of real-world effects to agricultural productivity, property values, human health, other climate-vulnerable market and nonmarket sectors, and the testimony below further explains the direct relevance of these figures to New Mexicans and to the Commission's decisions.

The New Mexico Public Regulation Commission ("Commission") has the authority and responsibility to fully weigh environmental externalities, including climate effects, in assessing the public convenience of retiring and replacing coal-fired electricity generating units such as at San Juan. Every ton of greenhouse gases emitted by electricity generation contributes in a measurable way to the health and welfare costs of climate change that are externalized onto the public. These costs are very real and damaging both to the entire world and specifically to New Mexico and its citizens, who end up paying for increased greenhouse pollution in the form of more dangerous wildfires, more heat-related stresses on energy infrastructure, more heat-related deaths, more droughts that tax groundwater resources and hurt agriculture, worse air quality, more erosion, threats to tribal communities, and so forth.

The best available estimates to value the global climate effects of each additional ton of greenhouse pollution were developed by the federal Interagency Working Group on the Social Cost of Greenhouse Gases. The Working Group's central estimate for the social cost of year 2020 emissions is about $50 per ton of carbon dioxide; its high-impact estimate is about $153 per ton for year 2020 emissions. Incorporating these metrics into the Commission's decisions about energy resources will provide the necessary context to weigh climate costs against other costs and benefits, will transparently convey the benefits of the Commission's decisions to the public, and will set a useful precedent for other states to follow in weighing climate effects in their own energy policy decisions, which will have reciprocal benefits back to New Mexico. Indeed, a growing number of states are already using the Interagency Working Group's estimates of the social cost of carbon in their energy resource decisions.

In the case of retiring the remaining San Juan coal units, the total avoided social costs—or, conversely, the social benefits—of reducing carbon dioxide emissions will be several billion dollars. Depending on the replacement portfolio, the net present value of climate benefits would be over $1.5 billion using the Interagency Working Group's central estimate, or over $4.8 billion using the high-impact estimates (over an emission forecast period from 2022-2028). These figures represent the benefits of avoiding the global, social externalities of carbon emissions from the San Juan coal units, in terms of real-world effects to agriculture, property values, human health, other climate-vulnerable market and nonmarket sectors. New Mexico benefits both directly and indirectly from these emissions reductions, and the global damage framework is the appropriate perspective for New Mexico to take on valuing climate externalities.

These estimates are conservative for several reasons. First, these estimates are based mostly on one specific dataset of quantified emissions reductions; if a different dataset showed larger quantified emissions reductions, then the total monetized climate benefits would be larger as well. Second, while the Interagency Working Group estimates are the best currently available metrics, they omit several key categories of climate damages that are not currently monetizable, including increased wildfire severity, and so these estimates are widely considered to be conservative under-estimates. Third, this assessment of climate benefits measures the effects of reducing only carbon dioxide emissions from combustion. Upstream emissions, including carbon dioxide emissions from the transportation of coal and methane emissions from the production of coal, will also drop upon retirement of the San Juan units; if upstream emissions reductions were quantified, they could also be monetized by using the social cost of greenhouse gases, and the additional benefits would likely be valuable. Furthermore, this assessment focuses only on climate benefits. Retiring and replacing the San Juan coal-fired units will also reduce emissions of other harmful pollutants, including particulate matter. Those reductions will deliver additional health and environmental benefits.

Nevertheless, this analysis makes clear that many of the key environmental benefits of retiring the San Juan coal-fired units can be monetized, that climate benefits accrue directly and indirectly to New Mexico, that the total benefits will reach into the billions of dollars, and that these environmental benefits weigh strongly in favor of retiring the coal-fired units and replacing them with a portfolio of lower- or zero-carbon energy alternatives.

I. MONETIZATIZING ENVIRONMENTAL EXTERNALITIES IS IMPORTANT

Q: **WHY IS MONETIZATION OF ENVIRONMENTAL EXTERENALITIES IMPORTANT FOR EVALUATION OF THE PROPOSAL TO ABANDON THE SAN JUAN COAL-FIRED UNITS?**

A: This answer provides an overview, which we expand upon in subsequent answers below.

New Mexico's legal framework for making decisions about electricity resources requires a proper accounting of environmental effects and the net public benefit. To ensure that environmental effects are not given less weight in decisionmaking, to contextualize the significance of environmental effects, and to allow comparison of environmental effects against other costs and benefits, monetization of environmental externalities is the most appropriate approach. Regardless of legal requirements to weigh environmental effects, monetization of environmental externalities also promotes public understanding of the benefits of decisions made by the Commission.

These principles broadly support the monetization of any environmental externalities for which quantification and monetization methodologies exist. Greenhouse gas emissions are particularly suitable candidates for monetization, both because greenhouse gases are global pollutants, such that any ton of carbon dioxide emissions causes the same environmental harms regardless of the source of the emission, and because a widely accepted monetization tool exists: the federal Interagency Working Group's estimates of the Social Costs of Greenhouse Gases. The global nature of the climate effects of greenhouse gases also creates an additional reason to support the Commission incorporating the monetized social cost of greenhouse gas metrics into its energy resource decisions: reciprocity. By using the metric in decisions made in New Mexico, the Commission can set a precedent for other states and signal to foreign countries that the

United States remains committed to tackling global climate change. As New Mexico helps encourage other jurisdictions to likewise weigh the social cost of greenhouse gases in their decisions, New Mexico will benefit as other jurisdictions' emissions are reduced.

These points are expanded upon in the following answers.

A. New Mexico's Legal Framework

Q: **DO NEW MEXICO'S LAWS ALLOW FOR CONSIDERATION OF MONETIZED ENVIRONMENTAL EXTERNALITIES?**

A: Yes. New Mexico Public Utility Act § 62-9-5 governs abandonment of utility facilities. That section prescribes that "[t]he commission shall grant such permission and approval, after notice and hearing, upon finding that the continuation of service is unwarranted or that the *present and future public convenience and necessity* do not otherwise require the continuation of the service or use of the facility."[2] The statute continues to provide that "[i]n considering the present and future public convenience and necessity, the commission shall specifically consider the impact of the proposed abandonment of service on all consumers served in this state, directly or indirectly, by the facilities sought to be abandoned."[3] This broad language supports consideration of a wide range of effects that a plant closure would have on the public—both direct and indirect, and both positive and negative. Environmental effects should naturally be considered as a part of that analysis. Particularly relevant for the consideration of greenhouse gas emissions and their long-term effects on global climate, the Commission is instructed to consider "future public convenience" as well.

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[2] N.M. STAT. ANN. § 62-9-5 (emphasis added).

[3] *Id.*

The Commission has interpreted this "public convenience and necessity" standard to entail a weighing of the "net public benefit."[4] In other words, in evaluating a proposed utility project or closure, the Commission will assess whether that action results in net benefits for the public. The most effective way to determine whether a policy will result in a net benefit to the public—and especially to determine which approach will provide the maximum net benefit—is to evaluate all of the significant costs and benefits of the proposal to the public using a comprehensive cost-benefit analysis in a societal cost test. If environmental externalities like pollution are excluded from that analysis, the results will be distorted and could result in net costs to the public.

In order to ensure that environmental effects will be treated on par with the other costs and benefits in electric power decisionmaking, those environmental externalities will need to be monetized—that is, translated into a dollar value to represent their expected impact. When all costs and benefits are translated into the common metric of money, the tradeoffs inherent in policy choices become apparent, and decisionmakers can more readily and more transparently compare society's preferences for competing priorities.[5] For the Commission to effectively evaluate whether the proposed abandonment at issue will result in a "net public benefit"—as required by the Commission's interpretation of the "public convenience and necessity" assessment in Section 62-9-5—the analysis should monetize every environmental externality that is reasonably monetizable. Minimally, that must include valuing the costs of carbon dioxide

[4] *In re Valle Vista Water Util. Co.*, 212 P.U.R. 4th 305, 309 (2001); *accord New Energy Econ., Inc. v. N.M. Pub. Regulation Comm'n*, 2018-NMSC-024, 2018 N.M. LEXIS 18 at *P14, Dkt. No. S-1-SC-35697 (N.M. Mar. 5, 2018).

[5] For more details on why monetization of environmental effects is vital for reasoned decisionmaking, see, e.g., Peter Howard & Denise Grab, Testimony to New Jersey Legislature (Apr. 25, 2019), *available at* https://policyintegrity.org/documents/NJ_Legislature_SCC_Testimony.pdf.

emissions using a scientifically rigorous, widely endorsed method of calculating those costs, like the Social Cost of Carbon.

Though New Mexico courts have not directly ruled on whether utility regulators should consider environmental and public health effects under a "public convenience and necessity" analysis, courts in other jurisdictions have found that commissioners should consider these environmental effects in such determinations. The U.S. Court of Appeals for the D.C. Circuit even held that environmental effects are among the factors that the Federal Energy Regulatory Commission is *required* to consider in conducting its "public convenience and necessity" analysis under Section 7 of the Natural Gas Act.[6]

Other sections of the New Mexico Public Utility Act provide additional support for the consideration of environmental impacts in this abandonment proceeding. A provision of the statute describing siting of utility infrastructure instructs that "it is in the public interest to consider any adverse effect upon the environment and upon the quality of life of the people of the state that may occur due to plants, facilities and transmission lines needed to supply present and future electrical services."[7] Though the remainder of that statutory section refers to the siting of new plants, the principle that the Commission should consider the effect of plants upon the

[6] *See Sierra Club v. FERC*, 867 F.3d 1357, 1373 (D.C. Cir. 2017) ("Congress instructed the agency to consider 'the public convenience and necessity' when evaluating applications to construct and operate interstate pipelines. *See* 15 U.S.C. § 717f(e). FERC will balance 'the public benefits against the adverse effects of the project,' *see Minisink Residents for Envtl. Pres. & Safety v. FERC*, 762 F.3d 97, 101-02, 412 U.S. App. D.C. 97 (D.C. Cir. 2014) (internal quotation marks omitted), including adverse environmental effects, *see Myersville Citizens for a Rural Cmty. v. FERC*, 783 F.3d 1301, 1309, 414 U.S. App. D.C. 438 (D.C. Cir. 2015). Because FERC could deny a pipeline certificate on the ground that the pipeline would be too harmful to the environment, the agency is a legally relevant cause [under the National Environmental Policy Act] of the direct and indirect environmental effects of pipelines it approves." [internal quotation omitted]); *see also* Jayni Hein, Jason Schwartz & Avi Zevin, *Pipeline Approvals and Greenhouse Gas Emissions* 8–11 (Inst. for Policy Integrity Report 2019), https://policyintegrity.org/files/publications/Pipeline_Approvals_and_GHG_Emissions.pdf (explaining in more detail why the "public convenience and necessity" test requires FERC to consider environmental effects in evaluating pipelines under the Natural Gas Act).

[7] N.M. STAT. ANN. § 62-9-3(A).

environment and quality of life of New Mexicans should apply to abandonment of existing plants, as well.

A variety of other provisions in the Public Utility Act support the Commission's consideration of environmental effects and the public interest in its decisionmaking. For example, under the newly passed Energy Transition Act, "[i]n determining whether to approve replacement resources" for an abandoned generation facility, "the commission shall prefer resources with the least environmental impacts."[8] Additionally, in addressing renewable energy goals, the legislature finds that "the generation of electricity through the use of renewable energy presents opportunities to . . . pursue an improved environment in New Mexico" and that "the use of renewable energy by public utilities subject to commission oversight in accordance with the Renewable Energy Act can bring significant economic benefits to New Mexico."[9] By considering the cost of carbon damages in a thoughtful and rigorous way, using the Social Cost of Carbon, the Commission can effectively integrate environmental effects into the societal economic analysis and use that information to maximize net economic benefits to New Mexicans.

The Commission's regulations also could support consideration of the monetary costs of pollution, including greenhouse gas emissions, in the Commission's assessment of the proposed abandonment of the facilities at issue. In its regulations implementing the Integrated Resource Planning process, the Commission instructs utilities to determine the most cost-effective resource portfolio and alternative portfolios by considering certain factors, including "existing and anticipated environmental laws and regulations, and, if determined by the commission, the

[8] N.M. STAT. ANN. § 62-18-3(B).

[9] N.M. STAT. ANN. § 62-16-2(A)(1) & (2).

standardized cost of carbon emissions."[10] Though to date the Commission seems to have interpreted "standardized cost of carbon emissions" to refer to a shadow price or proxy for compliance with environmental regulation,[11] that is not the only interpretation possible, and the regulatory language could be consistent with a requirement to consider the *social* cost of environmental externalities created by carbon emissions; that is, the monetary cost of the damages to the welfare of New Mexico and the planet caused by climate damages.

Altogether, New Mexico's legal framework for making decisions about energy resources envisions a rigorous weighing of environmental effects and the public interest. The best way to fulfill that charge and ensure that environmental effects are sufficiently factored into decisions and are communicated to the public is to monetize the environmental externalities, as explored more in the next section.

B. Monetizing Informs Rational Decisions, Provides Transparency, and Promotes Reciprocity

Q: **HOW WILL MONETIZING THE IMPACTS OF EMISSIONS HELP INFORM RATIONAL DECISIONMAKING AND PUBLIC UNDERSTANDING?**

A: Monetizing the impacts of emissions facilitates comparison against other costs and benefits. Without such values, decisionmakers are faced with imperfect information; by contrast, when impacts are translated into the common metric of money, decisionmakers can more readily compare society's preferences for competing priorities, and the public can more readily understand the consequences of a regulatory choice.

[10] N.M. ADMIN. CODE § 17.7.3.9(G)(2)(c).

[11] *See infra* note 86 and accompanying text, on Order No. 06-00448-UT.

If an analysis only qualitatively discusses the externalities of emissions, decisionmakers and the public will both tend to overly discount the significance of the effects. In general, non-monetized effects are often irrationally treated as worthless.[12] This may be especially true when some effects (like capital cost and operational costs) are monetized, while other effects (like climate and health benefits) are discussed only quantitatively or qualitatively.

It also may be especially difficult for the public and decisionmakers to fully consider climate effects that are presented only quantitatively through estimates of emissions volumes. As the U.S. Environmental Protection Agency's website explains, "abstract measurements" of so many tons of greenhouse gases can be rather inscrutable for the public, unless "translat[ed] . . . into concrete terms you can understand."[13] After all, the roughly 2.5 million tons of emissions per year that the Public Service Company of New Mexico (PNM) estimates that the remaining San Juan coal-fired units would continue to emit[14] may seem like a trivial 0.04% of national emissions.[15] A well-documented mental heuristic called "probability neglect" causes people to irrationally reduce small probability risks entirely down to zero;[16] another well-document mental

[12] Richard Revesz, *Quantifying Regulatory Benefits*, 102 Cal. L. Rev. 1424, 1434-35, 1442 (2014).

[13] EPA, Greenhouse Gas Equivalencies Calculator, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator (last updated Sept. 2017).

[14] *See* NEE 1-72 Supplemental San Juan Continues Output Report: Resource Annual Emissions tab. Using the "San Juan Continues 8760" figures for the San Juan:1 and San Juan:4 resources, "CO2-ALL" emissions in 2019 are, for example, 2.5 million "tons." The emissions data from these spreadsheets is presumably presented in short tons. 2.5 million short tons is about 2.3 million metric tons. *See also* Direct Testimony of Thomas G. Fallgren, PNM Table TGF-2 (July 1, 2019) [hereinafter Fallgren Testimony], reporting that in 2023, the difference in emissions between the "San Juan Continues" scenario (5.6 million short tons) and, for example, Scenario 1 (2.9 million short tons), is 2.7 million short tons, which equals about 2.5 million metric tons. However, *compare* PNM Exhibit WRA 2-1, which suggests that in 2018, after units 2 and 3 were shut down but units 1 and 4 were still operational, San Juan's carbon dioxide emissions were still 5.9 million short tons total, with PNM's share of emissions still at 4.1 million short tons.

[15] *See* U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017* at ES-4 (2019) (reporting 6,456.7 million metric tons of carbon dioxide-equivalent emissions in year 2017). 2.5 million / 6,456.7 million = 0.000387.

[16] Cass R. Sunstein, *Probability Neglect: Emotions, Worst Cases, and Law*, 112 Yale L61, 63, 72 (2002) (drawing from the work of recent Nobel laureate economist Richard Thaler).

heuristic called "scope neglect" suggests that abstract volume estimates will fail to give people the required informational context to understand climate risks.[17] In this case, for example, many decisionmakers and interested citizens would wrongly reduce down to zero the climate risks associated with 0.04% of national emissions, simply due to the leading zero before the decimal. Similarly, while it is easy enough to tell that retiring the remaining San Juan coal units and their roughly 2.5 million tons or more per year of carbon dioxide emissions[18] would achieve reductions in emissions, without any additional context it may be difficult to weigh the precise climate consequences and significance of that reduction.

By contrast, the monetized expected cost of the climate risks associated with those same emissions from New Mexico's electricity sector—about $137 million per year according to the federal Interagency Working Group's central estimate of the social cost of carbon, or $410 million per year according to the high-impact estimate of the social cost of carbon[19]—is less

[17] Scope neglect, as explained by Nobel laureate Daniel Kahneman, among others, causes people to ignore the size of a problem when estimating the value of addressing the problem. For example, in one often-cited study, subjects were unable to meaningfully distinguish between the value of saving 2,000 migratory birds from drowning in uncovered oil ponds, as compared to saving 20,000 birds. Daniel Kahneman et al., *Economic Preferences or Attitude Expressions? An Analysis of Dollar Responses to Public Issues*, 19 J. Risk & Uncertainty 203, 212-213 (1999).

[18] The total net emissions reductions figure would depend, of course, on the greenhouse gas emissions of any replacement resources.

[19] The Interagency Working Group's central estimate of the social cost of carbon for year 2023 emissions is $44 per ton in 2007$; the high-impact estimate is $132 per ton in 2007$. *See* Interagency Working Group, *Technical Update on the Social Cost of Carbon for Regulatory Impact Analysis*, table A1 (2016) [hereinafter IWG, *2016 Technical Update*], *available at* https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf. Using the CPI Inflation Calculator, the central estimate is $54.61 per ton in 2018$, and the high-impact estimate is $163.84 per ton in 2018$.

2.5 million tons * $54.61 = $136.5 million. And 2.5 million tons * $163.84 = $409.6 million. In a full cost-benefit analysis, the stream of future benefits would be discounted back to present value and then summed. As explored further below in this testimony, in an actual comparison between the "San Juan Continues" baseline and various replacement scenarios, the difference in emissions between the scenarios may change over time; simultaneously, the value per ton of reducing those emissions will increase over time, since the social cost of carbon grows as the world's climate system becomes increasingly stressed; but then for a net present value figure, future benefits would be discounted.

likely overlooked, and the significance is more easily weighed. (This type of calculation is explored in much greater detail later in this testimony.)

Those annual monetized cost figures represents real-world impacts that are modeled in the social cost of carbon methodology:[20]

- changes in energy demand, from temperature-related changes to the demand for cooling and heating;
- lost productivity and other impacts to agriculture, forestry, and fisheries, due to alterations in temperature, precipitation, CO_2 fertilization, and other climate effects;
- human health impacts, including cardiovascular and respiratory mortality from heat-related illnesses, changing disease vectors like malaria and dengue fever, increased diarrhea, and changes in associated pollution;
- property lost or damaged by inland and coastal flooding, storms, other extreme weather events, as well as the cost of protecting vulnerable property and the cost of resettlement following property losses;
- changes in fresh water availability;
- ecosystem service impacts;
- impacts to outdoor recreation and other non-market amenities; and
- catastrophic impacts, including damages at very high temperatures.

[20] These impacts are all included to some degree in the three integrated assessment models (IAMs) used by the Interagency Working Group (namely, the DICE, FUND, and PAGE models), though some impacts are modeled incompletely, and many other important damage categories are currently omitted from these IAMs. *Compare* Interagency Working Group on the Social Cost of Carbon, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis* at 6-8, 29-33 (2010), https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf [hereinafter IWG, *2010 TSD*]; *with* Peter Howard, *Omitted Damages: What's Missing from the Social Cost of Carbon* (Cost of Carbon Project Report, 2014), http://costofcarbon.org/files/Omitted_Damages_Whats_Missing_From_the_Social_Cost_of_Carbon.pdf.

New Mexico is undeniably already experiencing the effects of climate change, and in both the near future and over the long term, unabated climate change will continue to cause significant impacts to both market and nonmarket sectors, including agriculture, energy use, water resources, human health, and ecosystem services. The federal government's most recent *National Climate Assessment* highlighted that New Mexico in particular faces increased wildfires, increased erosion, habitat reduction, threats to fisheries, threats to insect populations, biome shifts, threats to tribal communities, increased drought, increased aridity, threats to surface water and groundwater supplies, and threats to agriculture.[21] Throughout the Southwestern region more generally, in addition to droughts, floods, groundwater depletion, heat waves, crop and livestock disruptions, food insecurity, death and disease from extreme heat, poor air quality, pathogen spread, and productivity and labor losses,[22] there are also specific climate threats to the energy sector. The Southwestern region could see up to a 15% loss of energy efficiency due to heat-induced reductions, up to a 7% loss along transmission lines as increased temperatures increase electric resistance, up to a 9% drop in summer electricity generation potential due to drought,[23] and increased competition for water resources between the energy sector, municipal uses, and agriculture.[24]

Many, though not all, of these categories of significant climate impacts facing New Mexico are valued in the social cost of greenhouse gas methodology. Economists estimate and monetize such categories of climate damages by linking together global climate models with global economic models, producing what are called integrated assessment models. These

[21] U.S. Global Change Research Program, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment: Volume II* at 1116, 1117, 1122, 1127 (2018), https://nca2018.globalchange.gov/.
[22] *Id.* at 1111, 1126, 1129.
[23] *Id.* at 1124.
[24] *Id.* at 1126.

integrated assessment models can take a single additional unit of greenhouse gas emissions (such as from burning coal at a power plant) and calculate the change in atmospheric greenhouse concentrations; translate that change in concentration into a change in temperature; and model how that temperature change and associated weather changes will cause economic damages. The resulting monetary estimate of how each additional unit of greenhouse gases will impact our health, our economic activity, our quality of life, and our overall well-being is called the social cost of greenhouse gases.

Such context is helpful to the Commission not only in making energy planning decisions, but also in explaining the chosen decision to New Mexico ratepayers and citizens. For example, the social cost of greenhouse gases will allow the Commission to highlight the monetized benefits of a decision to retire the San Juan coal units, helping the public understand the climate consequences of the decision.

Q: HOW WOULD NEW MEXICO'S ADOPTION OF THE GLOBAL SOCIAL COST OF CARBON SUPPORT RECIPROCAL GLOBAL ACTIONS THAT WILL BENEFIT NEW MEXICO?

A: Because greenhouse gases are global pollutants, there is another strong justification for the Commission to incorporate the monetized social cost of greenhouse gases in energy decisions: to encourage reciprocal actions by other states and countries, which will benefit New Mexico.

Greenhouse gases do not stay within geographic borders, but rather mix in the earth's atmosphere and affect climate worldwide. Greenhouse gases emitted in New Mexico therefore contribute to climate damages around the world, just as, conversely, greenhouse gases emitted outside New Mexico contribute to climate damages in New Mexico. Each ton of carbon dioxide causes the same global climate damages regardless of its source of origin, and New Mexico experiences its share of climate damage from every ton of greenhouse gases emitted by another state or another country.

At the same time, New Mexico is also undeniably already benefiting from the efforts of other jurisdictions to curb their greenhouse gas emissions. From Europe's Emissions Trading System to California's recently expanded cap-and-trade program, every ton of emissions reduced outside the state delivers some direct benefit to New Mexico. Global actions on climate change have already helped the United States as a whole avoid more than $200 billion in direct economic damages, with potentially hundreds of billions more at stake if other countries continue to take efficient actions on climate change.[25] With New Mexico facing particularly high climate risks from air quality changes, extreme temperature mortality, labor and productivity effects, increased electricity demand, municipal water supply needs, and wildfire,[26] a large portion of the benefits of foreign action accrue to New Mexico.

New Mexico stands to benefit greatly as other U.S. states and other countries apply a global social cost of greenhouse gas value to their regulatory decisions and so weigh the externalities of their emissions that will fall on New Mexico. It is therefore rational for New Mexico to use the social cost of greenhouse gases in its own decisionmaking, because it will encourage other states and countries to follow suit. Indeed, several significant players—

[25] Peter Howard & Jason Schwartz, *Foreign Action, Domestic Windfall: The U.S. Economy Stands to Gain Trillions from Foreign Climate Action* (Policy Integrity Report, 2015), http://policyintegrity.org/publications/detail/foreign-action-domestic-windfall.

[26] *See* Jeremy Martinich & Allison Crimmins, *Climate Damages and Adaptation Potential Across Diverse Sectors of the United States*, 9 Nature Climate Change 397, 400 fig. 1 (2019) (showing geographic distribution of selected project climate impacts across the United States).

including the United Kingdom, Sweden, Germany, and Norway—have already developed their own estimates of the global social cost of greenhouse gases.[27] Canada and Mexico have explicitly borrowed the U.S. Interagency Working Group's estimates to set their own carbon emission standards.[28] Similarly, several U.S. states have begun to apply the federal Interagency Working Group's estimates of the global social cost of carbon to their electricity policy and regulatory decisions, including Colorado, Nevada, Minnesota, California, Washington, and others. (See *infra* for more on how other states are valuing the social cost of greenhouse gases.)

New Mexico should join those states as a leader in climate policy by applying the social cost of greenhouse gases in its energy decision-making. Not only will it help continue to set a precedent for other states to follow suit, but it will be a strong signal to foreign countries that the United States remains committed to reducing the global externalities of our emissions. Such a signal is consistent with the pledge New Mexico made when it joined the U.S. Climate Alliance,[29] as well as the goals set in the recently passed Energy Transition Act.[30] As other states and other countries respond by likewise applying the social cost of greenhouse gases and continuing to reduce their externalities as well, New Mexico will benefit.

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[27] Peter Howard & Jason Schwartz, *Think Global: International Reciprocity as Justification for a Global Social Cost of Carbon*, 42 Columb. J. Envtl. L. 203 (2017). Some countries have started to move toward an abatement cost approach to set regulatory stringency, especially for designing carbon prices. Nevertheless, these countries have still developed social cost metrics to value the costs and benefits of their policies.

[28] *Id.*

[29] U.S. Climate Alliance, Release: New Mexico Governor Michelle Lujan Grisham Joins U.S. Climate Alliance, Jan. 29, 2019, https://www.usclimatealliance.org/publications/2019/1/29/new-mexico-governor-michelle-lujan-grisham-joins-us-climate-alliance.

[30] For example, legislative sponsor Sen. Jacob Candelaria highlighted the importance of the Act to "cement[ ] New Mexico's place as a national leader." *See* Office of the Governor, New Mexico, Press Release: Governor Signs Landmark Energy Legislation, Establishing New Mexico as a National Leader in Renewable Transition Efforts, Mar. 22, 2019, https://www.governor.state.nm.us/2019/03/22/governor-signs-landmark-energy-legislation-establishing-new-mexico-as-a-national-leader-in-renewable-transition-efforts/.

II. BEST PRACTICES FOR MONETIZING CLIMATE DAMAGES

Q: WHAT ARE BEST PRACTICES FOR PROPERLY MONETIZING ENVIRONMENTAL EXTERNALITIES?

A: This answer provides an overview, which we expand upon in subsequent answers below.

To ensure that all important environmental externalities that can be monetized are, in fact, monetized and accounted for in the decision-making framework, first all important environmental effects must be quantified: that is, the scope of the impact must be measured, such as by calculating the tons of emissions. Ideally, all important upstream and downstream emissions should be quantified, including non-carbon emissions like methane, and emissions should be quantified on an annual basis rather than just one or a few spot estimates for particular years.

Greenhouse gas emissions should then be monetized (that is, translated into a dollar value) using the federal Interagency Working Group's 2016 estimates of the social cost of greenhouse gases. The social cost of greenhouse gas methodology uses integrated assessment models that can translate each additional ton of quantified emissions into changes in atmospheric chemistry, temperature, and, ultimately, economic damages. The Working Group's 2016 estimates are the best available, are based on peer-reviewed methodologies and data, have been thoroughly vetted by external reviewers and the public, and have been adopted by a growing number of states in their electricity decisionmaking. "Carbon prices" that the Commission has required in the past and that the Public Service Company of New Mexico (PNM) incorporate into its model in this application are, essentially, proxies for regulatory stringency, and do not substitute for a methodology for monetizing the *social* costs of climate change.

A. Quantification

Q: IS THERE QUANTITATIVE DATA TO SUPPORT MONETIZATION OF ALL SIGNIFICANT EMISSIONS FROM THE SAN JUAN PLANT?

A: Before environmental externalities can be monetized in terms of their social costs, first the effects of an action such as shutting down a coal plant must be quantified, such as by measuring the expected changes in tons of emissions. The materials in the testimony attached to PNM's application for the abandonment and replacement of the coal-fired units at San Juan report emissions changes only for carbon dioxide in a single year, 2023.[31] Moreover, presumably these emissions figures for year 2023 cover only downstream carbon dioxide from combustion of fossil fuels at electricity generating units.[32] There are several shortcomings with this approach to quantification of environmental effects that limit the ability to fully monetize the environmental externalities of the various decision options.

First, though carbon dioxide emissions from combustion likely are the most significant single environmental effect, not only will the annual emissions of the various scenarios change over time, but the value of the monetized climate damages from emissions changes over time as well. The climate damage generated by each additional ton of greenhouse gas emissions depends on the background concentration of greenhouse gases in the global atmosphere. Once emitted, greenhouse gases can linger in the atmosphere for centuries, building up the concentration of radiative-forcing pollution and affecting the climate in cumulative, non-linear ways.[33] As

[31] *See, e.g.*, Fallgren Testimony, PNM Table TGF-2. Note that the NEE 1-72 Supplemental Reports do have additional data for additional pollutants and additional years.

[32] There is no mention of upstream emissions in the Fallgren Testimony or the Direct Testimony of Nick Wintermantel Testimony (July 1, 2019) [hereinafter Wintermantel Testimony]. The NEE 1-72 Supplemental Reports do refer to emissions as, for example "CO2-ALL" and "NOx-ALL." It is not clear whether that descriptor "ALL" is intended to indicate that upstream emissions are included, or that related pollutants are included (such as converting methane to CO_2-equivalent units or including various nitrogen oxides), or perhaps something else.

[33] Carbon dioxide also has cumulative effects on ocean acidification, in addition to cumulative radiative-forcing effects.

physical and economic systems become increasingly stressed by climate change, each marginal additional ton of emissions has a greater, non-linear impact. The climate damages generated by a given amount of greenhouse pollution is therefore a function not just of the pollution's total volume but also the year of emission, and with every passing year an additional ton of emissions inflicts greater damage.[34] In short, the timing of greenhouse gas emissions matters greatly, and so presenting only a single year of emissions data in the Fallgren and Wintermantel testimonies provides an incomplete picture.[35] If the Commission moves toward requiring more monetization of environmental externalities—as it should—it will need to require utilities to provide more annual data on emissions.

Second, carbon dioxide is not the only pollutant from the electricity sector that causes monetizable externalities. Other greenhouse gas pollutants, particularly methane, also cause significant climate damages, especially in the short term, and monetized estimates of the social cost of methane and the social cost of nitrous oxide are readily available and can be applied to emissions from any source.[36] Besides greenhouse gases, coal-fired power plants emit sulfur dioxide, nitrogen oxides, particulate matter, volatile organic compounds, and toxic heavy metals (including mercury). These pollutants cause significant public health impacts, including

[34] *See* 2010 TSD, *supra* note 20, at 28 (explaining that the social cost of greenhouse gas estimates grow over time).

[35] The NEE 1-72 Supplemental Reports do report emissions out to the year 2038. However, even that is incomplete, as a 20-year analytical timeframe (which is what Wintermantel uses for costs, *see* Wintermantel Testimony at 13-14) should extend from the planned date of retirement in 2022 until at least 2041, or else from 2023-2042, *see* Wintermantel Exhibit NW-2 at 6 (extrapolating production costs out to 2042).

[36] Interagency Working Group, Addendum: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide (2016) [hereinafter IWG, *2016 Addendum*], https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/august_2016_sc_ch4_sc_n2o_addendum_final_8_26_16.pdf. Separate estimates for the social cost of methane and the social cost of nitrous oxide are important, since different greenhouse gases have different climate impacts based on their individual capacity to absorb the sun's energy and their lifespans in the earth's atmosphere. It is more accurate to apply each greenhouse gas's own social cost metric, rather than converting non-carbon gases into CO_2-equivalent units by using the relative global warming potentials of gases, because the individual metrics better reflect the damages associated with each gas's unique atmospheric chemistry.

cardiovascular disease and premature mortality, as well as negative impacts to property, crops, forests, and recreation.[37] Some of those key health impacts, as well as some other welfare effects, have been monetized (per kilowatt-hour of coal-fired electricity generation) in peer-reviewed studies. Regional or national average estimates of the monetized damages from these pollutants, such as particular matter, sulfur dioxide, and nitrogen oxides, are also available.[38] It is very possible that the same model that PNM used to quantify downstream carbon dioxide emissions could also generate estimates of downstream emissions of other air pollutants, and once quantified, some of those other air pollutants could also be monetized.[39] Additional types of environmental externalities, like water pollution, are notoriously more difficult to quantify let alone monetize, but should also be considered at least qualitatively.

Finally, downstream emissions from combustion of fossil fuels are not the only environmental externalities that matter. Upstream emissions—such methane releases from coal mining, other air and water pollution from coal mining, carbon dioxide emissions from coal-by-rail transportation,[40] and methane releases from the production, processing, and transportation of

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[37] Nat'l Res. Council, *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use* (2010); P.R. Epstein et al., *Full Cost Accounting for the Life Cycle of Coal*, 1219 Annals of the N.Y. Acad. of Sci. 73 (2011). Examples of non-health impacts include acid rain and harmful algal blooms, dead zones, and decreased water quality from excess nitrogen.

[38] *See* Jeffrey Shrader et al., *Valuing Pollution Reductions: How to Monetize Greenhouse Gas and Local Air Pollutant Reductions from Distributed Energy Resources* at 19-27 (Inst. for Policy Integrity Report, 2018), *available at* https://policyintegrity.org/files/publications/Valuing_Pollution_Reductions.pdf (providing several examples of monetized damages per megawatt-hour for sulfur dioxide, nitrogen oxides, and fine particulate matter). *See also* Declaration of Dr. Peter Howard, Doc. 115-8, *Western Org. of Res. Councils v. BLM*, case no. cv-16-21-GF-BMM (D. Mont., filed May 25, 2018), *available at* https://policyintegrity.org/documents/WORC_v_BLM,_SCC_declaration_PH.pdf (distilling from the literature a central estimate of about $0.11 in health externalities per kilowatt-hour of coal combustion as a national average).

[39] Note that the NEE 1-72 Supplemental Reports do provide estimates for some additional pollutants. However, some key pollutants, like particulate matter, are not clearly listed (though could be captured either in "COALASH-ALL" as a related type of particle, or in "NOx-ALL" and "SO2-ALL" as precursors).

[40] *See* Jayni Hein & Peter Howard, *Illuminating the Hidden Costs of Coal* at tbls. B7-B8 (Policy Integrity Report 2015), http://policyintegrity.org/files/publications/Hidden_Costs_of_Coal.pdf.

natural gas[41]—can also be significant. The quantification and monetization of upstream emissions like methane may be especially important when comparing scenarios for replacing the generation from the San Juan units with different energy resources.[42] To the extent important upstream emissions can be quantified, they should.[43]

B. The Interagency Working Group on the Social Cost of Greenhouse Gases

Q: IS THERE A CONSENSUS AMONG SCIENTISTS AND ECONOMISTS ABOUT HOW BEST TO PLACE A DOLLAR VALUE ON THE HARMS FROM GREENHOUSE GAS EMISSIONS?

A: In 2009, an Interagency Working Group assembled experts from a dozen federal agencies and White House offices to "estimate the monetized damages associated with an incremental increase in [greenhouse gas] emissions in a given year" based on "a defensible set of input assumptions that are grounded in the existing scientific and economic literature."[44] The estimates are based on the three most cited, most peer-reviewed models built to link physical impacts to the economic damages of each additional ton of greenhouse gas emissions. Those three leading

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[41] *See generally* Jayni Hein et al., *Pipeline Approvals*, *supra* note 6.

[42] For example, research by the Environmental Defense Fund suggests that New Mexico's oil and gas companies actually emit five times more methane than estimated by the U.S. Environmental Protection Agency. EDF, Explore New Mexico's Oil and Gas Pollution, https://www.edf.org/energy/explore-new-mexicos-oil-and-gas-pollution (last visited Oct. 17, 2019); *see also* Renee McVay et al., *Oil and Gas Methane Emissions in New Mexico* (EDF Report 2018), https://www.edf.org/sites/default/files/new-mexico-methane-analysis.pdf. The approximately one million tons per year of methane released by New Mexico's oil and gas operators not only wastes a valuable resource that would be worth $275 million per year on the market (and $43 million per year in tax and royalty revenue), *id.* but causes significant climate damages as well: about $1.4 billion per year. (The social cost of methane for year 2020 emissions, converted to 2017$, is $1419 per metric ton. *See* IWG, 2016 Addendum, *supra* note 36.) When comparing scenarios with continued coal-fired generation or new gas-fired generation against scenarios with more or exclusively renewable generation, upstream emissions could matter greatly.

[43] Again, as discussed above, *supra* note 39, it is not clear if by "ALL" the NEE 1-72 Supplemental Reports intended to indicate coverage of upstream emissions.

[44] IWG, 2010 TSD, *supra* note 20.

integrated assessment models are DICE (by Nobel laureate William Nordhaus of Yale University), FUND (by Richard Tol and David Anthoff of Sussex University and University of California-Berkeley), and PAGE (by Chris Hope of Cambridge University). These models are able to estimate and monetize many[45] of the most important categories of climate damages, including, but not limited to:

- changes in agricultural output and forestry due to alterations in temperature, precipitation, and CO_2 fertilization,
- changes in energy demand, via cooling and heating,
- property lost to sea-level rise,
- increased coastal storm damage,
- changes in heat-related illnesses,
- some changes in disease vectors, like malaria and dengue fever,
- changes in fresh water availability, and
- some general measures of catastrophic and ecosystem impacts.

The Working Group ran these models using inputs and reasonable assumptions drawn from the peer-reviewed literature, and the Working Group updated its estimates every few years—most recently in 2016—to reflect the latest and best scientific and economic data.[46] For each greenhouse gas, the Working Group issued a "central estimate" of social costs per metric ton of emissions per year based on a 3% discount rate and taking the average from a probability distribution; a "high-impact estimate" based on the 95th percentile of that probability distribution

[45] For a list of important damages categories not currently included in the models, see *infra* note 102 and accompanying text, on unquantified damages.

[46] IWG, 2016 Technical Update, *supra* note 19.

calculated at a 3% discount rate; as well as additional estimates that explore the calculation's sensitivity to a lower (2.5%) or higher (5%) discount rate.[47]

Discount rates are important because of the nature of greenhouse gases and climate change. Once emitted, greenhouse gases can linger in the atmosphere for centuries, building up the concentration of radiative-forcing pollution and affecting the climate in cumulative, non-linear ways.[48] The integrated assessment models project future climate damages over roughly a 300-year timescale. However, for a variety of reasons, society tends to care more about economic effects today than about economic effects in the future.[49] A discount rate is used to take all the marginal climate damages that an additional ton of emissions emitted this year will inflict over the next 300 years, and translate those future damages back into present-day values. The Working Group chose a 3% discount rate for its central estimate because of its consensus-driven approach to selecting inputs from the peer-reviewed literature. While the Working Group also considered a 2.5% rate and a 5% rate as sensitivity analyses, it specifically declined to use any rate as high as 7%, as such a rate is far outside the consensus in the economic community about the appropriate discount rate for intergenerational effects.[50] There is a strong consensus in the economic literature that a 3% or lower discount rate is appropriate for the social cost of greenhouse gases, and there is an emerging consensus that a declining discount rate would be the

[47] *See generally* 2010 TSD, *supra* note 20. The 5% discount rate was selected as an "upper value" to reflect "possibility that climate damages are positively correlated with market returns," *id.* at 23, while the 2.5% rate was used to reflect the fact that "interest rates are highly uncertain over time," *id.*

[48] Carbon dioxide also has cumulative effects on ocean acidification, in addition to cumulative radiative-forcing.

[49] However, many experts on climate policy and economics believe that a non-zero discount rate is inappropriate in the context of long-term climate change, because society really does not or should not care less about the welfare of future generations. *See* Richard Revesz & Matthew Shahabian, *Climate Change and Future Generations*, 84 S. Cal. L. Rev. 1097 (2011).

[50] Interagency Working Group on the Social Cost of Carbon, Response to Comments: Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12,866 at 36 (July 2015) [hereinafter IWG, 2015 Response] ("The use of 7 percent is not considered appropriate for intergenerational discounting. There is wide support for this view in the academic literature.").

preferred approach.[51]

The social cost of greenhouse gases increases over time, because an additional ton of emissions will inflict greater damages in the future as emissions accumulate in the atmosphere and climate and economic systems become increasingly stressed. The following table shows the Interagency Working Group's central and high-impact estimates for the social cost of carbon, by year of emissions.[52] The values in this table have been updated to account for inflation. The Working Group presented its estimates in 2007$; we have used data from the Bureau of Labor Statistics on the Consumer Price Index to convert those original figures into 2018$.[53]

Table 1. Social Cost of Carbon Estimates (in 2018$, per metric ton)

Year	**Central Estimate (at a 3% Discount Rate)**	**High-Impact Estimate (95th Percentile)**
2020	$52	$153
2025	$57	$171
2030	$62	$189
2035	$68	$209
2040	$74	$227
2045	$79	$245
2050	$86	$263

Importantly, the Working Group's central estimate omits key categories of climate damages—like the risk of catastrophic and irreversible consequences.[54] The high-impact estimate serves as a partial proxy for, among other things, omitted catastrophic damages, risk aversion, and other uncertainties.[55] Policy decisions should therefore be informed by using both sets of numbers.

[51] *See, e.g.*, Joint Comments to EPA, on the Flawed Monetization of Forgone Benefits in the Proposed Reconsideration of Oil and Natural Gas Sector: Emissions Standards for New, Reconstructed, and Modified Sources at 22-29 & Technical Appendix: Discounting (Dec. 7, 2018), *available at* https://policyintegrity.org/documents/Oil__Gas_NSPS_Joint_SCC_Comments.pdf.

[52] 2016 Technical Update, *supra* note 19, at table A1.

[53] Inflated from 2007$ to 2018$ using CPI data to adjust by a factor of 1.2412. Because this testimony is being prepared in October 2019, 2018$ have been selected, since the 2019 year is not over yet. The inflation factor from January 2007 to December 2018 (1.2412) is only very slightly lower than to the most recent month available, August 2019 (1.2675), and the difference should not significantly affect the calculations.

[54] 2010 TSD, *supra* note 20; Howard, *Omitted Damages*, *supra* note 20.

[55] 2010 TSD, *supra* note 20, at 25, 30.

The Working Group's estimates have been repeatedly endorsed by reviewers. In 2014, the U.S. Government Accountability Office reviewed the Working Group's methodology and concluded that it had followed a "consensus-based" approach, relied on peer-reviewed academic literature, disclosed relevant limitations, and adequately planned to incorporate new information via public comments and updated research.[56] In 2016, the U.S. Court of Appeals for the Seventh Circuit held that estimates of the social cost of carbon used to date by agencies were reasonable.[57] The U.S. District Courts for the Districts of Colorado and Montana have also chided federal agencies for their failure to use the Interagency Working Group's estimates of the social cost of carbon.[58] In 2016 and 2017, the National Academies of Sciences issued two reports that, while recommending future improvements to the methodology, supported the continued use of the existing Working Group estimates.[59] It is, therefore, unsurprising that scores of economists and climate policy experts have endorsed the Working Group's values as the best available estimates.[60] The Interagency Working Group's estimates have been used in nearly 100 federal regulatory proceedings, and counting, each subject to a thorough public comment period.[61]

[56] Gov't Accountability Office, *Regulatory Impact Analysis: Development of Social Cost of Carbon Estimates* 12-19 (2014).

[57] *Zero Zone, Inc. v. Dep't of Energy*, 832 F.3d 654, 679 (7th Cir. 2016).

[58] *High Country Conservation Advocates v. Forest Service*, 52 F. Supp. 3d 1174, 1191 (D. Colo. 2014); *Montana Environmental Information Center v. Office of Surface Mining*, 274 F. Supp. 3d 1074 (D. Mont. 2017).

[59] Nat'l Acad. Sci., Eng. & Medicine, *Valuing Climate Damages: Updating Estimates of the Social Cost of Carbon Dioxide* 3 (2017); Nat'l Acad. Sci., Eng. & Medicine, *Assessment of Approaches to Updating the Social Cost of Carbon: Phase 1 Report on a Near-Term Update* 1 (2016).

[60] *See, e.g.*, Richard Revesz et al., *Best Cost Estimate of Greenhouse Gases*, 357 Science 655 (2017); 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, 42 (2013); Richard L. Revesz et al., *Global Warming: Improve Economic Models of Climate Change*, 508 Nature 173 (2014) (co-authored with Nobel Laureate Kenneth Arrow, among others); Decl. of Michael Hanemann ¶ 17, Wyoming v. Interior, No. 16-00285 (D. Wyo. Dec. 14, 2016), available at https://www.edf.org/sites/default/files/content/69.1-2016.12.15-Dec-of-M-Hanemann.pdf (explaining that the estimates that the Working Group prepared for the costs of methane are "the best available estimate of the environmental cost of an additional unit of methane emissions.").

[61] *See* Howard & Schwartz, *Think Global*, *supra* note 27, App. A (cataloguing uses in federal proceeding).

C. Best Practices of Other States

Q: DO OTHER STATES USE THE INTERAGENCY WORKING GROUP ESTIMATES FOR THE SOCIAL COST OF CARBON?

A. A number of states have recognized the importance of using the Interagency Working Group's social cost of carbon estimates and have begun using those values to measure the harms from carbon dioxide emissions in their proceedings. States considering the damage cost of carbon dioxide emissions in electricity decisionmaking include Colorado, Nevada, California, Washington, Illinois, Maine, Minnesota, New Jersey, and New York.[62] Notably, all states that have to date incorporated or are considering incorporating the social cost of greenhouse gases into their electricity decisionmaking have relied at least in part—and, more often, exclusively—on the Interagency Working Group's numbers or methodology.

A few key examples are worth exploring in more detail:

- *Planning, Acquisition, and Retirement Decisions:* Colorado, Nevada, and Washington have explicitly recognized the Interagency Working Group's 2016 estimates as the best available estimates for use in energy resource planning. In August 2018, the Nevada Public Utilities Commission updated its regulations requiring utilities to consider the economic and environmental benefits of their integrated resource plans, specifically requiring the monetization of the social costs of carbon and recommending use of the Working Group's estimates as reflecting "the best available science and economics."[63] In 2019, Colorado adopted a new statutory requirement for the Colorado Public Utilities

[62] *See generally*, Denise A. Grab et al., Opportunities for Valuing Climate Impacts in U.S. State Electricity Policy (Inst. for Policy Integrity Report, 2019), https://policyintegrity.org/files/publications/Valuing_Climate_Impacts.pdf.

[63] Nev. PUC, Order: Investigation and Rulemaking to Implement Senate Bill 65 (2017) (Aug. 20, 2018), http://pucweb1.state.nv.us/PDF/AxImages/DOCKETS_2015_THRU_PRESENT/2017-7/32153.pdf.

Commission to use a social cost of carbon based on the Working Group's 2016 technical support document in resource planning, as well as in applications for acquisition of new resources *and for retirement of existing resources*.[64] The Minnesota Public Utilities Commission has also ordered utilities to use social cost of carbon estimates based on the Working Group's methodology when planning new projects, including resource acquisition and diversification.[65] And in 2019, Washington adopted a new statutory requirement for utilities to use the Interagency Working Group's social cost of greenhouse gas estimates for resource planning and in the selection of resource options.[66]

- *Xcel Energy:* One of the utilities operating within the New Mexico Public Regulation Commission's jurisdiction is the Southwestern Public Service Company, which is a subsidiary of Xcel Energy. Xcel Energy also operates a subsidiary in Minnesota. In 2018, when an industrial group challenged the Minnesota Public Utility Commission's decision to monetize climate externalities, Xcel Energy filed a response supporting the efforts in Minnesota, and specifically arguing that the Interagency Working Group's methodology was "a reasonable and best available starting point for developing a new range of carbon dioxide environmental costs."[67] Xcel acknowledged that some uncertainty existed around the estimates, but concluded that the goal should "not [be] perfection but a reasonable and best available estimate to take these damages into account in resource selection."[68]

As the Commission considers weighing monetized externalities in not just this

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[64] Colo. Rev. Stat. § 40-3.2-106.

[65] Minn. PUC, E-999/CI-14-643.

[66] Wash. Sen. Bill 5116 (2019) §§ 14(1)(k)(3)(a), 15.

[67] Xcel Energy, Response to Petition for Reconsideration Investigation into Environmental and Socioeconomic Costs, Docket No. E999/CI-14-643, Feb. 2, 2018, *available at* https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={B0595861-0000-CA11-8965-2EB04B3FB6C7}&documentTitle=20182-139736-01.

[68] *Id.*

proceeding, but future resource plans and other proceedings as well, the praise offered by one of the state's regulated utilities for the Interagency Working Group methodology is notable.

- *Leaning Toward High-Impact Estimates:* In May 2019, the California Public Utilities Commission adopted an order that requires utilities to conduct a societal cost test to determine the cost-effectiveness of distributed energy resources.[69] The approach requires utilities to calculate the climate benefits of distributed energy resources by using the social cost of carbon estimates developed by the Interagency Working Group in 2016. Specifically, the order requires using the Working Group's "high-impact" estimate in addition to the central estimate.[70] A Staff Report prepared in that proceeding had in fact recommended favoring the high-impact values, because many of the climate damage categories most relevant to California's electricity infrastructure and economy—such as wildfires, thermal efficiency decreases, wind turbine efficiency effects, and overheating of electricity system components—are not fully incorporated into the central estimates of the social cost of carbon; consequently, the initial ruling of an administrative law judge had found "that *the high impact value is the more appropriate and defensible estimate*."[71] In another example, Washington's 2019 statute requiring utilities to use the Interagency Working Group's estimates specifies the use of estimates calculated "using the two and

[69] Before the Cal. PUC, 19-05-019, Decision Adopting Cost-Effectiveness Analysis Framework Policies for All Distributed Energy Resources (May 16, 2019), http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M293/K833/293833387.PDF.

[70] *Id.* at 42.

[71] Before the Cal. PUC, ALJ's Ruling Seeking Responses to Questions and Comment on Staff Amended Proposal on Societal Cost Test (Mar. 14, 2018), http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M212/K023/212023660.PDF.

one-half percent discount rate."[72] Several years earlier, Washington state agencies had similarly specified a preference for the 2.5% estimates, to "anticipate additional external costs," to better reflect an appropriate intergenerational discount rate, and to be a state leader on climate change, among other reasons.[73]

- *Upheld by State and Federal Courts:* New York and Illinois have both adopted Zero Emission Credit programs with valuations tied to the Interagency Working Group's estimates of the social cost of carbon. In September 2018, both New York's ZECs program and Illinois's ZECs program were upheld in federal court, partly because the values for the ZECs had been rationally and explicitly tied to the Working Group's estimates.[74] In October 2019, a New York state court did the same.[75]

New Mexico should join these states as a climate leader by adopting the Working Group's central and high-impact estimates into the Commission's decision frameworks.

D. The 2016 Working Group Estimates of Global Damages Remain the Best Available

Q: HAS THE FEDERAL GOVERNMENT CHANGED ITS APPROACH TOWARD VALUING EMISSION DAMAGES?

A: No developments since 2017 on how the federal government values the social cost of carbon change the fact that the Working Group's 2016 estimates remain the best available

[72] Wash. Sen. Bill 5116 § 15 (2019).

[73] Wash. Dept. of Commerce, *The Social Cost of Carbon: Washington State Energy Office Recommendation for Standardizing the Social Cost of Carbon When Used for Public Decision-Making Processes* (2014), http://www.commerce.wa.gov/wp-content/uploads/2015/11/Energy-EV-Planning-Social-Cost-of-Carbon-Sept-2014.pdf.

[74] *Electric Power Supply Ass'n v. Star*, No. 17-2433, 17-2445 (7th Cir., Sept. 13, 2018); *Coalition for Competitive Electricity v. Zibelman*, No. 17-2654-cv (2d. Cir., Sept. 27, 2018).

[75] *Hudson River Sloop Clearwater Inc v. NYSPSC,* No. 7242-16, at *19 (N.Y. Sup. Ct., Oct. 8, 2019) (calling the social cost of carbon "the best tool to reflect the environmental monetary damages attributable to reduced carbon").

estimates for states to use.

In March 2017, President Trump's Executive Order 13,783 disbanded the Interagency Working Group.[76] But the Executive Order does not alter the fundamental legal and economic principles that support full and accurate monetization of externalities. In fact, the Executive Order presumes that agencies may continue "monetizing the value of changes in greenhouse gas emissions,"[77] and some agencies under the current administration have continued to use the Working Group's estimates. For example, in August 2017, the Bureau of Ocean Energy Management called the Interagency Working Group's social cost of carbon "a useful measure" and applied it to analyze the consequences of offshore oil and gas drilling,[78] and in July 2017, the Department of Energy used the Interagency Working Group's 2016 estimates for carbon and methane emissions to analyze energy efficiency regulation, describing the social cost of methane as having "undergone multiple stages of peer review."[79] Thus, the unfortunate disbandment of the Interagency Working Group in no way puts into question the analytical rigor of its methodology. The Interagency Working Group's estimates continue to reflect the most thorough effort of the federal government to date to use the best science and the best economic models to estimate the costs of carbon and, notwithstanding Executive Order 13,783, the Commission and other New Mexico agencies should continue to rely on those estimates—just as other states have done.

The so-called "interim" values of the social cost of greenhouse gases developed recently by the U.S. Bureau of Land Management and the U.S. Environmental Protection Agency under

[76] Exec. Order. No. 13,783 § 5(b), 82 Fed. Reg. 16,093 (Mar. 28, 2017).

[77] *Id.* § 5(c)

[78] BOEM, *Draft Envtl. Impact Statement: Liberty Development Project* at 3-129, 4-246 (Aug. 2017).

[79] Energy Conservation Program: Energy Conservation Standards for Walk-In Cooler and Freezer Refrigeration Systems, 82 Fed. Reg. 31,808, 31,811, 31,857 (July 10, 2017).

the Trump administration are not appropriate for New Mexico to use. Those "interim" values wrongly attempt to calculate a domestic-only estimate, and also ignore the weight of consensus in the economic literature by adding a calculation at a 7% discount rate—a rate wholly inappropriate to the kind of intergenerational effects at stake with climate change.

As described above, the Interagency Working Group deliberately rejected any discount rate as high as 7% as inconsistent with the economic literature and economic principles.[80] Other experts concur that a "7% rate based on private capital returns is considered inappropriate because the risk profiles of climate effects differ from private investments."[81] The National Academies of Sciences, the U.S. Office of Management and Budget, and many prominent economists, including the independent economists who build the models underlying the social cost of greenhouse gas methodology, all agree that a discount rate based on the rate of return on private investment (such as a 7% rate) is not sound or defensible in the context of intergenerational climate damages.[82]

As explained more below, the attempt to limit the valuation to a "domestic-only" calculation is equally misguided. For even more discussion on why the "interim" social cost of greenhouse gas figures would be entirely inappropriate for New Mexico, please see various other materials from the Institute for Policy Integrity.[83]

[80] IWG, *Response to Comments* at 36 (2015), *available at* https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc-response-to-comments-final-july-2015.pdf (rejecting any discount rate higher than 5% as "not considered appropriate"). *See also supra*, note 50 and accompanying text.

[81] Revesz et al., *Best Cost Estimate of Greenhouse Gases*, *supra* note 60.

[82] For more details, see, e.g., Joint Comments to FERC on the Social Cost of Greenhouse Gases, at 12-19, July 25, 2018, https://policyintegrity.org/documents/Joint_Comments_FERC_Pipeline_NOI_Comments_072518.pdf.

[83] Policy Integrity, Issue Brief: How the Trump Administration Is Obscuring the Costs of Climate Change (2018), https://policyintegrity.org/publications/detail/how-the-trump-administration-is-obscuring-the-costs-of-climate-change; Joint Comments to EPA, *supra* note 51.

Q: WHY IS A GLOBAL PERSPECTIVE NECESSARY FOR VALUING THE SOCIAL COST OF CARBON EMISSIONS?

A: For greenhouse gases, fully valuing the costs and benefits necessitates a global perspective on climate damages. Several reasons explain why a full accounting of climate costs requires a global estimate of the social cost of greenhouse gases. First, the principles of reciprocity discussed above dictate the need for a global perspective. New Mexico cannot solve climate change on its own, and New Mexico benefits tremendously when other states and other countries reduce their greenhouse gas emissions. To encourage other jurisdictions to continue to take account of the externalities of their emissions imposed on New Mexico, New Mexico must likewise take account of the externalities of its emissions that fall outside state borders. The fragile tit-for-tat dynamic could fall apart in the face of too many jurisdictions turning a blind eye to their global externalities and considering only local effects. For example, soon after the Trump administration reversed course and developed its own, flawed, domestic-only "interim" values of the social cost of greenhouse gases, the country of Mexico also moved toward considering only domestic climate impacts in its regulatory analyses. In the long term, such a move could mean more emissions from Mexico, which will hurt the state of New Mexico and its citizens. To secure the reciprocal level of efficient action of greenhouse gas emissions, New Mexico should follow the lead of Colorado, Nevada, Minnesota, and other states, and use a global number.

Second, climate damages do not respect political borders. New Mexicans have financial and personal interests in businesses and property located outside New Mexico that may be affected by climate change. New Mexico's businesses depend on non-local economies to buy their exports, sell imports, and fill their supply chains. If rising temperatures and rising seas cause climate refugees or infectious disease vectors to migrate toward or within the United

States, New Mexico will feel the impacts along with the rest of the country. New Mexico's economy, public health, and security are all linked to globally interconnected systems. Because climate damages occurring outside New Mexico borders can spill over and affect New Mexicans, a global perspective on the social cost of greenhouse gases is required.[84]

Finally, no existing methodology can calculate accurately a domestic-only estimate. The models simply were not designed to produce such estimates: for example, the models do not account for any inter-regional spillover effects. Any approximate and speculative estimate based on factors like percentage of global GDP, or share of global coastline or landmass, will be inherently misleading, as they ignore inter-regional spillover effects and extraterritorial interests of citizens. Put quite simply, there is no New Mexico-only estimate of the social cost of greenhouse gases; only global estimates.[85]

Every state that has begun to incorporate the social cost of greenhouse gases is using a global damage estimate. Attempting to apply a New Mexico-specific estimate would be akin to a homeowner throwing trash in her neighbor's yard without considering the odors and pests that will spill back to her own property, or how the neighbor might retaliate in kind.

E. "Carbon Prices" Are Not Substitutes for the Social Cost of Carbon

Q: HOW DOES THE SOCIAL COST OF CARBON COMPARE TO "CARBON PRICES" USED BY THE COMMISSION AND PNM?

A: Though New Mexico's Public Regulation Commission and its utilities have experience using a shadow price of carbon to reflect regulatory compliance costs, monetizing environmental

[84] *See* Howard & Schwartz, *Think Global*, *supra* note 27.

[85] *See e.g.*, Joint Comments to U.S. Forest Service on Use of Social Cost of Carbon in Colorado Roadless Rule, at 11-14 (Jan. 15, 2016), *available at* http://policyintegrity.org/documents/Forest_Service_SDEIS_comments.pdf (explaining, for example, that there is no national-, Colorado-, or forest-only estimate of the social cost of carbon).

and health externalities through the social cost of greenhouse gas metrics is a distinct approach to valuing the impacts of electricity resource decisions. Whereas compliance costs are a factor of existing or expected regulatory stringency, the point of measuring climate externalities is to put both dirtier and cleaner energy resources on equal analytical footing for comparison and to transparently disclose the total costs that are being externalized onto the public.

In a 2007 order, the New Mexico Public Regulation Commission adopted "standardized carbon emissions costs" for use in integrated resource planning.[86] The order made clear that these "CO_2 prices" should be factored in "as an operating cost" and were intended to reflect, at least in large part, the state of environmental regulations, including any federal carbon standards.[87]

Similarly, according to the testimony and attached exhibit from Nick Wintermantel, "CO2 pricing" figures were estimated by Pace Global and "reflect a 20 year forecast of national costs per ton of CO_2 emitted."[88] The Wintermantel testimony does not provide any additional details on what exactly Pace Global factored into its carbon price estimates, but presumably the carbon price is a proxy for existing and/or anticipated environmental regulations, likely including renewable portfolio standards and potential state and federal emissions standards. It is unclear when Pace Global made these estimates. PNM had also contracted with Pace Global in August 2016 to develop carbon price estimates for the utility's 2017 IRP.[89] Those August 2016 estimates

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[86] NM PRC, Case No. 06-00448-UT, Order Approving Recommended Decision and Adopting Standardized Carbon Emissions Costs for Integrated Resource Plans (June 19, 2007).

[87] *Id.*; *see also* New Mexico Admin. Code § 17.7.3.9(G)(2)(c) (tying "standardized cost of carbon emissions" to "existing and anticipated environmental laws and regulations"); *but see supra* (explaining that "standardized cost of carbon emission" could be interpreted to include the social as well as the regulatory costs of carbon).

[88] Wintermantel Testimony, PNM Exhibit NW-2 at 24.

[89] PNM, Integrated Resource Plan: 2017-2036, at 85 (July 2017) [hereinafter PNM, 2017 IRP], *available at* https://www.pnm.com/documents/396023/396193/PNM+2017+IRP+Final.pdf/eae4efd7-3de5-47b4-b686-1ab37641b4ed.

were based on "carbon pricing models [that Pace Global] had developed to advise previous clients."[90] Perhaps those same estimates were used in the model runs supporting this application as well. As such, though it is possible that the carbon pricing developed by Pace Global and used by PNM in Wintermantel's testimony reflects some version of federal carbon regulation, it is somewhat unlikely to reflect, for instance, the renewable energy and decarbonization goals that New Mexico recently adopted in its 2019 Energy Transition Act.

Regardless, because they are tied to predictions about *regulatory* costs, neither the Public Regulation Commission's carbon prices nor Wintermantel's carbon prices measure the *social* cost of greenhouse gas emissions. If regulations existed that were calibrated to the optimal level of stringency from the perspective of finding the economically efficient equilibrium, then marginal compliance costs would equal marginal social benefits.[91] But no existing or even prospective regulations at the state or federal level—not a revival of the federal Clean Power Plan and not even implementation of New Mexico's newly adopted targets from the Energy Transition Act—would necessarily achieve optimal emissions reductions on the optimal timeline from the perspective of maximizing net *social* benefits. Anticipated compliance costs are not a useful proxy for climate externalities and are not a substitute for using the social cost of greenhouse gas estimates to internalize the actual economic damages from climate change and to make efficient, informed decisions. In one of the starkest differences, PNM's carbon prices are $0 per ton until the year 2025, whereas the social cost of carbon "is certainly not zero."[92]

The charts below show the three sets of estimates—the Commission's carbon prices from Order 06-00448-UT, PNM's carbon prices, and the Interagency Working Group's social cost of

[90] *Id.*

[91] Even at the point of economically efficient regulation, additional environmental externalities would exist; it just would not necessarily be strictly economically efficient to regulate them.

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

carbon estimates—all plotted on the same Y- and X-axes, to facilitate comparison. Though Order 06-00448-UT does not clearly specify the dollar-years or an approach toward inflation, we assume that the prescribed 2.5%-per-year "escalat[ion]" rate is the only intended adjustment, and no further adjustment to account for inflation has been made.[93] The Commission Order gave the original standardized prices per metric ton of carbon dioxide. The Wintermantel testimony gives central and high carbon prices for the years 2023, 2028, and 2033; the central figures match numbers that can also be derived from data in the NEE 1-72 Supplemental reports, which then provides additional terms for the years 2024-2038. All those carbon prices, from the Wintermantel testimony and from the NEE 1-72 Supplement reports, were presumably given per short ton,[94] and so they have been converted to be per metric ton. The dollar-year is not specified, and so no further adjustments for inflation have been made. In the chart below, the Interagency Working Group's central and high-impact estimates for carbon dioxide have been graphed, adjusted from 2010$ to 2018$ to account for inflation.[95]

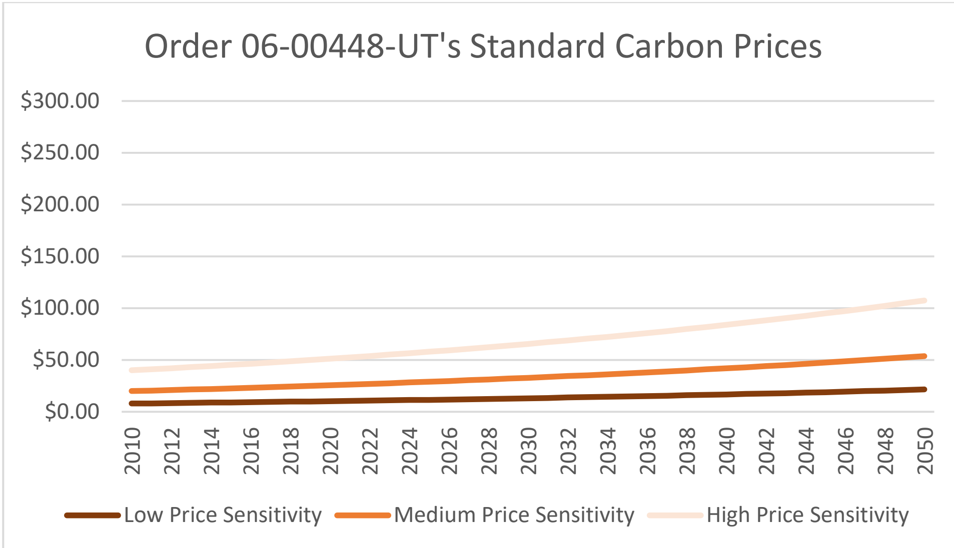
It is clear from that graphical comparison that the carbon prices used to date by the Commission and PNM are not a substitute for consideration of the social cost of carbon. Therefore, in the next section of this testimony, the Interagency Working Group's estimates of the social cost of carbon are applied to the emissions reductions anticipated from the abandonment and replacement of San Juan's remaining coal-fired units.

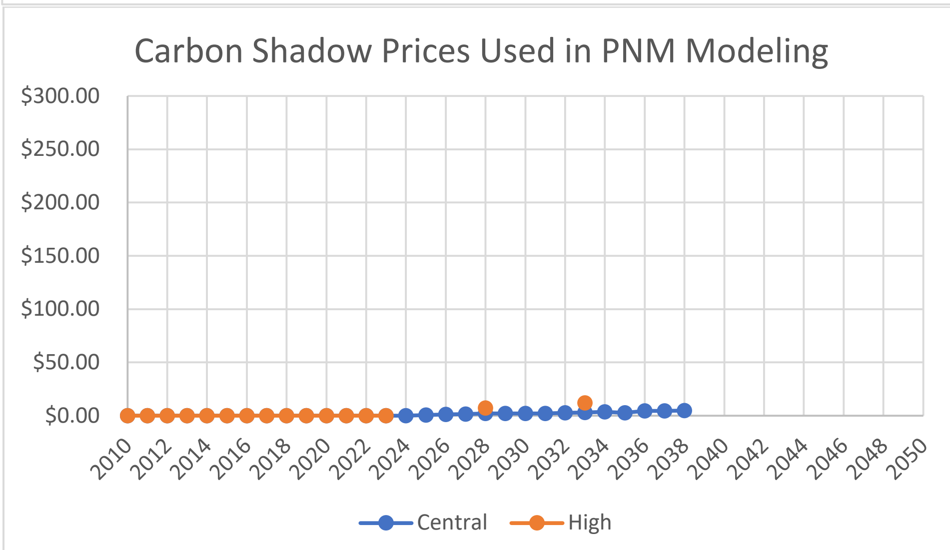
[93] *See also* PNM, 2017 IRP, *supra* note 89, at 87, fig. 27. Comparison of those figures used by PNM in 2017 to the starting figures from the 2010 order and the growth rate, suggests that PNM did not apply to the Commission's standardized prices any additional inflation factor besides the 2.5% escalation rate. That in turn suggests that the Commission did not intend for its standardized prices to be adjusted by anything other than the 2.5 escalation rate.

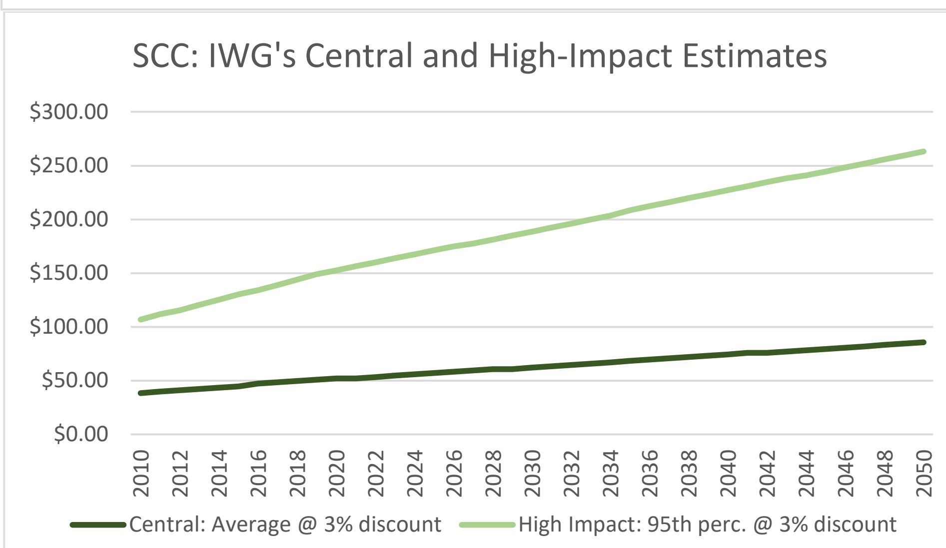
[94] Emissions figures for non-greenhouse gas pollutants are commonly given in short tons. Because the NEE 1-72 Supplement reports use the same units of "tons" for all its emissions figures, we presume the carbon dioxide emissions are given in short tons as well.

[95] IWG, 2016 TSD, *supra* note 20, at Appendix A. Per the CPI Inflation Calculator, an adjustment of 1.2412 has been applied. *See supra* note 53 for an explanation on why conversion to 2018$ is the currently the most appropriate approach to inflation.

Charts 1-3: Comparison of Carbon Price/Cost Estimates, Per Metric Ton







III. MONETIZED BENEFITS OF CLOSING THE SAN JUAN COAL-FIRED UNITS

Q: HAVE YOU MONETIZED THE BENEFITS OF CLOSING THE SAN JUAN PLANT? WHICH REPLACEMENT SCENARIO, IF ANY, DO YOU ASSUME?

A: Yes. As detailed in the rest of this testimony, we have monetized the costs of the carbon dioxide that San Juan's coal-fired units would continue to emit if not retired, and we have monetized the benefits of replacing the coal-fired units with PNM's proposed Scenario 1. Due to current data limitations, we will not yet monetize the comparative benefits of Scenarios 2, 3, or 4. Such additional scenarios may be analyzed in future testimony, either as an addendum or in connection with the future proceeding on selecting the replacement portfolio. The limitations of this testimony's current approach should not be interpreted to suggest that Scenario 1 is the preferable replacement portfolio. Instead, the benefits of moving to Scenario 1 simply illustrate that retiring San Juan's coal-fired units and replacing them with a reasonable substitute portfolio will generate significant environmental benefits.

A. Data Sources on Emissions

Q: HOW DID YOU QUANTIFY THE CARBON EMISSIONS FOR THE VARIOUS PORTFOLIOS? WHAT ARE YOU DATA SOURCE?

A: We have access to two sources of quantitative estimates of carbon emissions under various portfolios. In the testimony of Thomas G. Fallgren, PNM Table TGF-2 shows carbon emissions in the year 2023 for various scenarios: specifically, 5.6 million short tons under San Juan Continues, and 2.9 million short tons under Scenario 1 (as well as, for example, 2.6 million short tons for Scenario 3 and 2.5 million short tons for Scenario 4). These estimates come from the model runs reported by the Nick Wintermantel testimony, which generally reports data (at least for effects other than carbon emissions) for the years 2023, 2028, and 2033. As such, we understand that additional emissions estimates may be available at least for years 2028 and 2033 (if not other years as well). If such additional data for both the San Juan Continues scenario and Scenario 1 becomes available,[96] we may be able to update this testimony with an addendum in the future.

For now, all that we can conclude from the Fallgren/Wintermantel data is that, as compared to the San Juan Continues scenario, Scenario 1 will reduce carbon emissions in the year 2023 by 2.7 million short tons, which equals 2.45 million metric tons.

A second data source is available through the NEE 1-72 Supplemental Reports, which detail both annual and monthly emissions on a company-wide, area-wide, and resource/unit-specific basis.[97] Though the reports do not specify, we presume all figures are given in short tons,[98] and so convert to metric tons. Emissions figures for "CO2-ALL," "COALASH," "HG-ALL," "NOx-ALL," "SO2-ALL" and "WATER" are given for years 2019 through 2038. It is not clear what "ALL" is intended to indicate, though it seems unlikely that the figures include upstream emissions. Though it could be possible to monetize some of the emissions figures given for nitrogen oxides (NOx) and sulfur dioxide (SO_2),[99] given the lack of comparable data in the Fallgren and Wintermantel testimonies on these non-carbon emissions, the uncertainty over if and how particulate matter emissions might or might not be included in such tallies, and the time constraints, our present analysis will focus on the carbon dioxide emissions. If the data can be

[96] On October 14, 2019, the Coalition for Clean Affordable Energy submitted its sixth set of interrogatories and requests for production of documents to PNM, requesting such data.

[97] There are two sets of data in each spreadsheet: one labeled just "[Scenario Name]", and one labeled "[Scenario Name]-8760." We use the latter. The company-wide and area-wide annual emissions figures seem to be identical within each sheet, although no precise definition of "area" is given.

[98] *See supra* note 94.

[99] *See, e.g.*, Shrader et al., *Valuing Pollution Reductions*, *supra* note 38 (on methodology and off-the-shelf estimates for monetizing key non-carbon pollutants).

clarified, we may be able to update this analysis for the subsequent proceeding on the selection of a replacement portfolio.

According to the NEE 1-72 Supplemental Reports, the following emissions will occur under various scenarios:

Table 2: CO_2 Emissions, from NEE 1-17 Supplemental Data (converted to metric tons)

Year	San Juan Continues: PNM-Wide Emissions	SJ Continues: Emissions *Just* from SJ Units 1 & 4	Scenario 1: PNM-Wide Emissions	PNM-Wide *Reductions* Moving from SJ Continues to Scenario 1
2022	3,374,533	**2,239,793**	2,444,472	**-930,060**
2023	3,320,496	**2,159,815**	1,804,295	**-1,516,201**
2024	3,124,686	**2,023,145**	1,612,580	**-1,512,106**
2025	3,263,720	**2,147,115**	1,678,296	**-1,585,423**
2026	3,262,124	**2,116,033**	1,739,225	**-1,522,899**
2027	3,047,236	**1,960,063**	1,535,520	**-1,511,715**
2028	3,043,899	**1,991,865**	1,565,058	**-1,478,841**
2029	3,027,868	**1,955,336**	1,581,518	**-1,446,351**
2030	2,750,018	**1,716,570**	1,426,367	**-1,323,651**
2031	2,837,252	**1,801,747**	1,457,784	**-1,379,468**
2032	2,355,269	**2,268,834**	841,856	**-1,513,412**
2033	2,065,855	**2,034,569**	593,480	**-1,472,375**
2034	2,215,667	**2,170,805**	508,842	**-1,706,825**
2035	2,354,599	**2,267,565**	685,014	**-1,669,585**
2036	2,087,380	**2,056,577**	499,886	**-1,587,494**
2037	2,222,996	**2,168,597**	476,962	**-1,746,034**
2038	2,453,195	**2,377,638**	432,041	**-2,021,154**

The first column reports company-wide emissions in the San Juan Continues scenario. The second column uses the "Resource Annual Emissions" tab from the San Juan Continues report to pull out specifically the carbon dioxide emissions from the San Juan 1 and San Juan 4 units. This column can be thought of as the emissions that will drive the climate costs directly attributable to continuing San Juan—or, alternatively, as what the climate benefits would be if the San Juan units could be retired without any offsetting emissions generated by the replacement portfolio. However, several of the replacement portfolios under contemplation would entail either new fossil fuel-fired generation or generation-shifting to existing fossil fuel-fired generation, both of which would carry some additional emissions that would partially offset the reductions from a pure retirement of the San Juan units. Therefore, the third column shows the company-wide emissions for Scenario 1. Again, the use of Scenario 1 data here is only intended to be illustrative and does not imply that Scenario 1 is the preferred replacement option from the perspective of environmental externalities. The fourth column in the table then shows the difference between the company-wide emissions for the San Juan Continues baseline (i.e., the first column) versus Scenario 1 (i.e., the third column). Notably, the reductions tallied in the fourth column are quite stable from year to year: the average annual reduction over the 17-year period is about 1.5 million metric tons, and except for the first and last year in the range, the figures for each individual year stay within 15% or less of that average.

The average annual emissions reduction calculated from the NEE 1-17 Supplemental Data for moving from the San Juan Continues baseline to Scenario 1 (1.52 million metric tons), is obviously different than the figure given for year 2023 emissions reductions in the Fallgren and Wintermantel testimonies (2.45 million metric tons). The figures came from two different models, which we have been informed took different approaches to issues like reliability. We do not make any assumptions about which data set is preferable.

B. Monetized Benefit Calculations

Q: HOW DID YOU MONETIZE THE CARBON EMISSION REDUCTIONS FROM CLOSING THE PLANT?

A: To monetize the 2.45 million metric tons that Fallgren and Wintermantel calculate will be reduced in the year 2023 by replacing the San Juan units with Scenario 1, we simply multiply that emissions tally by the social cost of carbon estimates for year 2023 emissions: specifically, a central estimate of $54.61 per metric ton, and a high-impact estimate of $163.84 per metric ton. The undiscounted totals for year 2023 emissions are a central estimate of $133.8 million, and a high-impact estimate of $401.3 million.[100]

Table 3: Monetized Benefits from Fallgren/Wintermantel Data (undiscounted)

Year	Central Social Cost of Carbon Estimate	High-Impact Social Cost of Carbon Estimate
2023	$133,768,565	$401,305,695

Again, these figures represent a single year's worth of climate benefits in terms of reductions in real-world impacts like property damage, lost agricultural productivity, and human health effects. Though Fallgren's and Wintermantel's testimonies only provide a single year of emissions, there likely would be comparable climate benefits in other years. Again it is perhaps notable that the annual emissions reductions calculated by the other dataset (the NEE Supplemental reports) were quite stable year-to-year relative to the average over the whole period of analysis. If the Fallgren/Wintermantel estimate of the emissions reduction from switching to Scenario 1 similarly remained roughly stable over the 20-year period of analysis, after factoring in the annual growth of the social cost of carbon and then discounting back to present value, the total climate benefits over twenty years would almost certainly reach into the billions of dollars.

The data from the NEE 1-72 Supplemental Reports can be monetized in two useful ways. First, we can monetize the climate costs of the emissions specifically from the San Juan coal units; the mirror image of that figure could be thought of as the climate benefits of retiring the San Juan coal units without any offsetting emissions generated by the replacement portfolio. Second, we can monetize the climate benefits of switching from the San Juan Continues baseline to a different replacement portfolio, such as Scenario 1. Again, the focus of the analysis in this

[100] If those figures were discounted back to present value as of the year 2019 at a 3% discount rate, the totals would be, respectively, $118.9 million and $356.6 million.

initial report on Scenario 1 should not be interpreted to suggest that Scenario 1 is necessarily the preferable replacement portfolio. Instead, the benefits of moving to Scenario 1 simply illustrate that retiring San Juan's coal-fired units and replacing them with a reasonable substitute portfolio will generate significant environmental benefits.

The following table shows a calculation of present value, discounting future benefits back to year 2019 at a 3% discount rate,[101] using both the Interagency Working Group's central and high-impact estimates of the social cost of carbon.

Table 3: Monetized Benefits from the NEE 1-72 Supplemental Data (2018$, NPV for year 2019)

Year	Central Social Cost of Carbon Estimates		High-Impact Social Cost of Carbon Estimates	
	Negative Costs of SJ Units 1 & 4 Emissions / Positive Benefits of Retiring SJ with No Offsetting Emissions	Benefits of Moving from the SJ Continues Baseline to Scenario 1	Negative Costs of SJ Units 1 & 4 Emissions / Positive Benefits of Retiring SJ with No Offsetting Emissions	Benefits of Moving from the SJ Continues Baseline to Scenario 1
2022	$109,397,246	$45,426,546	$328,191,739	$136,279,637
2023	$104,800,216	$73,570,276	$314,400,647	$220,710,827
2024	$97,475,417	$72,853,479	$292,426,251	$218,560,436
2025	$102,667,153	$75,809,126	$308,001,458	$227,427,379
2026	$100,369,458	$72,235,392	$301,108,375	$216,706,177
2027	$92,183,954	$71,097,645	$274,631,363	$211,811,735
2028	$92,845,882	$68,932,536	$276,642,833	$205,390,820
2029	$88,488,539	$65,454,450	$269,077,395	$199,034,960
2030	$76,959,790	$59,343,848	$233,957,762	$180,405,299
2031	$79,994,299	$61,245,887	$243,119,927	$186,139,459
2032	$99,715,787	$66,514,832	$302,982,582	$202,102,760
2033	$88,484,829	$64,034,620	$268,793,537	$194,520,259
2034	$93,389,497	$73,428,743	$283,627,361	$223,005,813
2035	$96,464,759	$71,026,012	$294,655,991	$216,952,181
2036	$86,485,216	$66,758,873	$264,088,785	$203,852,987
2037	$90,120,866	$72,560,349	$303,252,149	$221,500,013
2038	$97,613,138	$82,977,785	$297,888,368	$253,225,310
Total NPV	**$1,597,456,045**	**$ 1,163,270,399**	**$4,856,846,524**	**$3,517,626,053**

[101] It is appropriate to use a 3% discount rate again here, given that the underlying social cost of carbon estimates were developed using a 3% discount rate. Conservatively, we discount back to present value as of year 2019, even though 2019 is almost over as of the time this testimony was written.

Notably, the data from the NEE 1-72 Supplemental Reports ends in year 2038, even though the climate benefits of the retirement and replacement scenarios would continue into the future. That said, the benefits that we can monetize from the NEE 1-72 Supplemental data are significant. For example, if it were possible to retire San Juan's coal-fired units and replace them with a portfolio that did not add any additional carbon emissions, the monetized benefits would reach over $1.5 billion using the Interagency Working Group's central estimate, or over $4.8 billion using the high-impact estimates.

Q: IS YOUR MONETIZATION OF THE BENEFITS OF CARBON REDUCTIONS FROM CLOSING THE PLANT A CONSERVATIVE ESTIMATE OF THE TRUE BENEFITS FROM CLOSING THE PLANT?

A: Yes. Even the calculation of up to $4.8 billion in climate benefits, based on the NEE 1-72 Supplemental data, could be a conservative underestimate. To begin, as noted above, climate benefits would not suddenly end after the year 2038 just because the data stops at the point; instead, climate benefits would continue into the future. Second, the above calculations focus only on downstream emissions of carbon dioxide. Including upstream emissions as well as emissions of non-carbon dioxide pollutants would further increase the monetized benefits.

Finally, the Interagency Working Group's methodology for calculating the social cost of greenhouse gases excludes significant health, environmental, and welfare impacts, such as:

- Wildfires, including acreage burned, health impacts from smoke, property losses, and deaths;
- Agricultural impacts, including food price spikes and changes from heat and precipitation extremes;

- Death, injuries, and illnesses from omitted natural disasters and interruptions in the supply of water, food, sanitation, and shelter;
- Impacts on labor productivity from extreme heat and weather;
- Catastrophic impacts and tipping points, including rapid sea level rise and damages at very high temperatures;
- Ocean acidification and extreme weather effects on fisheries and coral reefs;
- Biodiversity and habitat loss, and species extinction;
- Changes in land and ocean transportation;
- National security impacts from regional conflict, including from refugee migration stemming from extreme weather and from food, water, and land scarcity;
- And many more categories.[102]

Consequently, while the Working Group's estimates remain among the best available for government decisionmakers to use, they are widely acknowledged to be underestimates, perhaps severely so.[103] Though the Working Group's high-impact estimate was developed as an imperfect proxy for some of these omissions, it is still important for analysts to make clear when using the Working Group's estimates that important climate effects may be underestimated, and

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[102] Howard, *Omitted Damages*, *supra* note 20. For more on wildfires specifically, see Peter H. Howard, *Flammable Planet: Wildfires and the Social Cost of Carbon* (Policy Integrity/Cost of Carbon Report, 2014), https://costofcarbon.org/files/Flammable_Planet__Wildfires_and_Social_Cost_of_Carbon.pdf. For other lists of actual climate effects, including air quality mortality, extreme temperature mortality, lost labor productivity, harmful algal blooms, spread of West Nile virus, damage to roads and other infrastructure, effects on urban drainage, damage to coastal property, electricity demand and supply effects, water supply and quality effects, inland flooding, lost winter recreation, effects on agriculture and fish, lost ecosystem services from coral reefs, and wildfires, *see* EPA, *Multi-Model Framework for Quantitative Sectoral Impacts Analysis: A Technical Report for the Fourth National Climate Assessment* (2017); U.S. Global Change Research Program, *Climate Science Special Report: Fourth National Climate Assessment* (2017); EPA, *Climate Change in the United States: Benefits of Global Action* (2015); Union of Concerned Scientists, *Underwater: Rising Seas, Chronic Floods, and the Implications for U.S. Coastal Real Estate* (2018).

[103] *See* Revesz et al., *Global Warming: Improve Economic Models of Climate Change*, *supra* note 60.

analysts should disclose and qualitatively discuss the important categories of omitted damages listed above.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes. This testimony makes clear that many of the key environmental benefits of retiring the San Juan coal-fired units can be monetized, that climate benefits accrue directly and indirectly to New Mexico, that the total benefits will reach into the billions of dollars, and that these environmental benefits weigh strongly in favor of retiring the coal-fired units and replacing them with a portfolio of lower- or zero-carbon energy alternatives.