TECHNICAL MEMORANDUM

TO: Docket for Rulemaking, "Proposed Federal Implementation Plan Addressing Regional Ozone Transport for the 2015 Ozone National Ambient Air Quality Standards" (EPA-HQ-OAR-2021-0668)
DATE: March 22, 2022
SUBJECT: Addendum to the Regulatory Impact Analysis: Monetizing Climate Benefits for the Proposed FIP for Addressing Regional Ozone Transport for the 2015 Ozone NAAQS

I. Introduction

There will be climate benefits associated with the CO_2 emissions reductions projected in the regulatory impact analysis (RIA) to occur from the Proposed Federal Implementation Plan Addressing Regional Ozone Transport for the 2015 Ozone National Ambient Air Quality Standards (proposed rule). Climate benefits from reducing emissions of CO_2 can be monetized using estimates of the social cost of carbon (SC-CO_2). However, due to a court order, EPA did not present these monetized estimates in the RIA for the proposed rule. On February 11, 2022, the U.S. District Court for the Western District of Louisiana issued an injunction concerning the monetization of benefits of greenhouse gas emission reductions by EPA and other defendants. See *Louisiana v. Biden*, No. 21-cv-01074-JDC-KK (W.D. La., Feb. 11, 2022). The proposed rule was signed on February 28, 2022, when the injunction was in effect. Accordingly, monetized climate benefits are not presented in the benefit-cost analysis of the proposed RIA conducted pursuant to E.O. 12866.

On March 16, 2022, the United States Court of Appeals for the Fifth Circuit granted a stay of the preliminary injunction in *Louisiana v. Biden* pending appeal. As a result of the stay of the injunction, the EPA is including this memorandum in the docket to include the estimated monetized climate benefits from CO_2 reductions projected to result from the proposed rule, as an addendum to the RIA for the proposed rule. As discussed below, the climate benefits are monetized using interim SC-CO_2 estimates developed for use in benefit-cost analyses until updated estimates of the impacts of climate change can be developed based on the best available science and economics. EPA finds that these estimates, while likely an underestimate, are the best currently available SC-CO_2 estimates. As stated in the RIA accompanying the proposed rule, the SC-CO_2 estimates used to monetize climate impacts are not relied upon as part of the record basis for the proposed rule. However, we invite comment on these estimates, as described at the end of this memorandum. At this time, EPA plans on reporting the monetized climate benefits in the RIA for the final rule, subject to any further legal developments in *Louisiana v. Biden* or other cases.

II. Estimated Climate Benefits from Reducing CO_2

We estimate the social benefits of CO_2 emission reductions projected to occur as a result of this proposed rule using the SC-CO_2 estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990* (IWG 2021) (hereafter, "February 2021 TSD"). The SC-CO_2 is the monetary value of the net harm to society associated with a marginal increase in CO_2 emissions in a given year, or the benefit of avoiding that increase. In principle, SC-CO_2 includes the value of all climate change impacts (both negative and positive), including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk, natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC-CO_2, therefore, reflects the societal value of reducing emissions of CO_2 by one metric ton. The SC-CO_2 is, therefore, an estimate of the marginal benefit of CO_2 abatement along the baseline and the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect CO_2 emissions. In practice, data and modeling limitations naturally restrain the ability of SC-CO_2 estimates to include all of the important physical, ecological, and economic impacts of climate change, such that the estimates are a partial accounting of climate change impacts and will therefore, tend to be underestimates of the marginal benefits of abatement.

We have evaluated the SC-CO_2 estimates in the February 2021 TSD and have determined that these estimates are appropriate for use in estimating the social benefits of CO_2 emission reductions expected to result from this proposed rule. These SC-CO_2 estimates are interim values developed for use in benefit-cost analyses until updated estimates of the impacts of climate change can be developed based on the best available science and economics. After considering the TSD, and the issues and studies discussed therein, EPA finds that these estimates, while likely an underestimate, are the best currently available SC-CO_2 estimates. These SC-CO_2 estimates are the same as those used in the 2016 Final CSAPR Update RIA.

EPA and other federal agencies began regularly incorporating SC-CO_2 estimates in benefit-cost analyses conducted under Executive Order (E.O.) 12866[1] in 2008, following a court ruling in which an

[1] Under E.O. 12866, agencies are required, to the extent permitted by law and where applicable, "to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs."

agency was ordered to consider the value of reducing CO_2 emissions in a rulemaking process. The SC-CO_2 estimates presented here were developed over many years, using a transparent process, peer-reviewed methodologies, the best science available at the time of that process, and with input from the public. Specifically, in 2009, an interagency working group (IWG) that included experts from the EPA and other executive branch agencies and offices was established to develop estimates relying on the best available science for agencies to use. The IWG published SC-CO_2 estimates in 2010 that were developed from an ensemble of three widely cited integrated assessment models (IAMs) that estimate climate damages using highly aggregated representations of climate processes and the global economy combined into a single modeling framework. The three IAMs were run using a common set of input assumptions in each model for future population, economic, and CO_2 emissions growth, as well as equilibrium climate sensitivity (ECS) – a measure of the globally averaged temperature response to increased atmospheric CO_2 concentrations. These estimates were updated in 2013 based on new versions of each IAM.[2] In 2015, as part of the response to public comments received to a 2013 solicitation for comments on the SC-CO_2 estimates, the IWG announced a National Academies of Sciences, Engineering, and Medicine review of the SC-CO_2 estimates to offer advice on how to approach future updates to ensure that the estimates continue to reflect the best available science and methodologies. In January 2017, the National Academies released their final report, *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide*, and recommended specific criteria for future updates to the SC-CO_2 estimates, a modeling framework to satisfy the specified criteria, and both near-term updates and longer-term research needs pertaining to various components of the estimation process (National Academies 2017). Shortly thereafter, in March 2017, President Trump issued Executive Order 13783, which disbanded the IWG, withdrew the previous TSDs, and directed agencies to ensure SC-CO_2 estimates used in regulatory analyses are consistent with the guidance contained in OMB's Circular A-4, "including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates" (E.O. 13783, Section 5(c)). Benefit-cost analyses following E.O. 13783 used SC-CO_2 estimates that attempted to focus on the U.S.-specific share of climate change damages as estimated by the models and were calculated using two discount rates recommended by Circular A-4, 3 percent and 7 percent. All other methodological decisions and model versions used in SC-CO_2 calculations remained the same as those used by the IWG in 2010 and 2013, respectively.

[2] Dynamic Integrated Climate and Economy (DICE) 2010 (Nordhaus 2010), Climate Framework for Uncertainty, Negotiation, and Distribution (FUND) 3.8 (Anthoff and Tol 2013a, 2013b), and Policy Analysis of the Greenhouse Gas Effect (PAGE) 2009 (Hope 2013).

On January 20, 2021, President Biden issued Executive Order 13990, which re-established an IWG and directed it to develop updated estimates of the social cost of carbon, methane, and nitrous oxide (collectively referred to as SC-GHG) that reflect the best available science and the recommendations of the National Academies (2017). The IWG was tasked with first reviewing the SC-GHG estimates currently used in Federal analyses and publishing interim estimates within 30 days of the E.O. that reflect the full impact of GHG emissions, including by taking global damages into account. As noted above, EPA participated in the IWG but has also independently evaluated the interim SC-CO_2 estimates published in the February 2021 TSD and determined they are appropriate to use here to estimate the climate benefits associated with this proposed rule. EPA and other agencies intend to undertake a fuller update of the SC-GHG estimates that takes into consideration the advice of the National Academies (2017) and other recent scientific literature.

The EPA has also evaluated the content of the February 2021 TSD, including the studies and methodological issues discussed therein and concludes that it agrees with the rationale for these estimates presented in the TSD and summarized below.

In particular, the IWG concluded that the SC-GHG estimates used since E.O. 13783 fail to reflect the full impact of GHG emissions in multiple ways. First, the IWG concluded that those estimates fail to capture many climate impacts that can affect the welfare of U.S. citizens and residents. Examples of affected interests include direct effects on U.S. citizens and assets located abroad, international trade, U.S. military assets and interests abroad, and tourism, and spillover pathways such as economic and political destabilization and global migration that can lead to adverse impacts on U.S. national security, public health, and humanitarian concerns. Those impacts are better captured within global measures of the social cost of greenhouse gases.

In addition, assessing the benefits of U.S. GHG mitigation activities requires consideration of how those actions may affect mitigation activities by other countries, as those international mitigation actions will provide a benefit to U.S. citizens and residents by mitigating climate impacts that affect U.S. citizens and residents. A wide range of scientific and economic experts have emphasized the issue of reciprocity as support for considering global damages of GHG emissions. Using a global estimate of damages in U.S. analyses of regulatory actions allows the U.S. to continue to actively encourage other nations, including emerging major economies, to take significant steps to reduce emissions. The only way to achieve an efficient allocation of resources for emissions reduction on a global basis—and so benefit the U.S. and its citizens—is for all countries to base their policies on global estimates of damages.

Therefore, for the climate benefits calculations presented in this technical memorandum, EPA centers attention on a global measure of SC-CO_2. This approach is the same as that taken in EPA regulatory analyses over 2009 through 2016. A robust estimate of climate damages to U.S. citizens and residents does not currently exist in the literature. Existing estimates are both incomplete and an underestimate of total damages that accrue to the citizens and residents of the U.S. because they do not fully capture the regional interactions and spillovers discussed above, nor do they include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature, as discussed further below. EPA, as a member of the IWG, will continue to review developments in the literature, including more robust methodologies for estimating the magnitude of the various damages to U.S. populations from climate impacts and reciprocal international mitigation activities, and explore ways to better inform the public of the full range of carbon impacts.

Second, the IWG concluded that the use of the social rate of return on capital (7 percent under current OMB Circular A-4 guidance) to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the SC-GHG. Consistent with the findings of the National Academies and the economic literature, the IWG continued to conclude that the consumption rate of interest is the appropriate discount rate in an intergenerational context (IWG 2010, 2013, 2016a, 2016b), and recommended that discount rate uncertainty and relevant aspects of intergenerational ethical considerations be accounted for in selecting future discount rates.[3] Furthermore, the damage estimates developed for use in the SC-GHG are estimated in consumption-equivalent terms, and so an application of OMB Circular A-4's guidance for regulatory analysis would then use the consumption discount rate to calculate the SC-GHG. EPA agrees with this assessment and will continue to follow developments in the literature pertaining to this issue. EPA also notes that while OMB Circular A-4, as published in 2003, recommends using 3% and 7% discount rates as "default" values, Circular A-4 also reminds agencies that "different regulations may call for different emphases in the analysis, depending on the nature and complexity of the regulatory issues and the sensitivity of the benefit and cost estimates to the key assumptions." On discounting, Circular A-4 recognizes that "special ethical considerations arise when comparing benefits and costs across generations," and Circular A-4

[3] GHG emissions are stock pollutants, where damages are associated with what has accumulated in the atmosphere over time, and they are long lived such that subsequent damages resulting from emissions today occur over many decades or centuries depending on the specific greenhouse gas under consideration. In calculating the SC-GHG, the stream of future damages to agriculture, human health, and other market and non-market sectors from an additional unit of emissions are estimated in terms of reduced consumption (or consumption equivalents). Then that stream of future damages is discounted to its present value in the year when the additional unit of emissions was released. Given the long time horizon over which the damages are expected to occur, the discount rate has a large influence on the present value of future damages

acknowledges that analyses may appropriately "discount future costs and consumption benefits…at a lower rate than for intragenerational analysis." In the 2015 Response to Comments on the Social Cost of Carbon for Regulatory Impact Analysis, OMB, EPA, and the other IWG members recognized that "Circular A-4 is a living document" and "the use of 7 percent is not considered appropriate for intergenerational discounting. There is wide support for this view in the academic literature, and it is recognized in Circular A-4 itself." Thus, EPA concludes that a 7% discount rate is not appropriate to apply to value the social cost of greenhouse gases in the analysis presented in this memorandum. In this analysis, to calculate the present and annualized values of climate benefits, EPA uses the same discount rate as the rate used to discount the value of damages from future GHG emissions, for internal consistency. That approach to discounting follows the same approach that the February 2021 TSD recommends "to ensure internal consistency—i.e., future damages from climate change using the SC-GHG at 2.5 percent should be discounted to the base year of the analysis using the same 2.5 percent rate." EPA has also consulted the National Academies' 2017 recommendations on how SC-GHG estimates can "be combined in RIAs with other cost and benefits estimates that may use different discount rates." The National Academies reviewed "several options," including "presenting all discount rate combinations of other costs and benefits with [SC-GHG] estimates."

While the IWG works to assess how best to incorporate the latest, peer reviewed science to develop an updated set of SC-GHG estimates, it recommended the interim estimates to be the most recent estimates developed by the IWG prior to the group being disbanded in 2017. The estimates rely on the same models and harmonized inputs and are calculated using a range of discount rates. As explained in the February 2021 TSD, the IWG has concluded that it is appropriate for agencies to revert to the same set of four values drawn from the SC-GHG distributions based on three discount rates as were used in regulatory analyses between 2010 and 2016 and subject to public comment. For each discount rate, the IWG combined the distributions across models and socioeconomic emissions scenarios (applying equal weight to each) and then selected a set of four values for use in benefit-cost analyses: an average value resulting from the model runs for each of three discount rates (2.5%, 3%, and 5%), plus a fourth value, selected as the 95th percentile of estimates based on a 3 percent discount rate. The fourth value was included to provide information on potentially higher-than-expected economic impacts from climate change, conditional on the 3% estimate of the discount rate. As explained in the February 2021 TSD, this update reflects the immediate need to have an operational SC-GHG for use in regulatory benefit-cost analyses and other applications that was developed using a transparent process, peer-reviewed methodologies, and the science available at the time of that process.

Table 1 summarizes the interim SC-CO_2 estimates for the years 2020 to 2050. These estimates are reported in 2016 dollars but are otherwise identical to those presented in the IWG's 2016 TSD (IWG 2016a). For purposes of capturing uncertainty around the SC-CO_2 estimates in analyses, the February 2021 TSD emphasizes the importance of considering all four of the SC-CO_2 values. The SC-CO_2 increases over time within the models – i.e., the societal harm from one metric ton emitted in 2030 is higher than the harm caused by one metric ton emitted in 2025 – because future emissions produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change, and because GDP is growing over time and many damage categories are modeled as proportional to GDP.

Table 1. Interim Social Cost of Carbon Values, 2020-2050 (2016$/Metric Tonne CO_2)

Emissions Year	Discount Rate and Statistic			
	5% Average	3% Average	2.5% Average	3% 95th Percentile
2020	$13	$47	$71	$140
2025	$15	$52	$77	$160
2030	$18	$57	$83	$170
2035	$20	$63	$90	$190
2040	$23	$67	$95	$210
2045	$26	$73	$100	$220
2050	$29	$78	$110	$240

Note: These SC-CO_2 values are identical to those reported in the 2016 TSD (IWG 2016a) adjusted for inflation to 2016 dollars using the annual GDP Implicit Price Deflator values in the U.S. Bureau of Economic Analysis' (BEA) NIPA Table 1.1.9 (U.S. BEA 2021). The values are stated in $/metric tonne CO_2 (1 metric tonne equals 1.102 short tons) and vary depending on the year of CO_2 emissions. This table displays the values rounded to the nearest dollar; the annual unrounded values used in the calculations in this technical memo are available on OMB's website: https://www.whitehouse.gov/omb/information-regulatory-affairs/regulatory-matters/#scghgs

There are a number of limitations and uncertainties associated with the SC-CO_2 estimates presented in Table 1. Some uncertainties are captured within the analysis, while other areas of uncertainty have not yet been quantified in a way that can be modeled. Figure presents the quantified sources of uncertainty in the form of frequency distributions for the SC-CO_2 estimates for emissions in 2030. The distributions of SC-CO_2 estimates reflect uncertainty in key model parameters such as the equilibrium climate sensitivity, as well as uncertainty in other parameters set by the original model developers. To highlight the difference between the impact of the discount rate and other quantified sources of uncertainty, the bars below the frequency distributions provide a symmetric representation of quantified variability in the SC-CO_2 estimates for each discount rate. As illustrated by the figure, the assumed discount rate plays a critical role in the ultimate estimate of the SC-CO_2. This is because CO_2 emissions today continue to impact society far out into the future, so with a higher discount rate, costs that accrue to

future generations are weighted less, resulting in a lower estimate. As discussed in the February 2021 TSD, there are other sources of uncertainty that have not yet been quantified and are thus not reflected in these estimates.

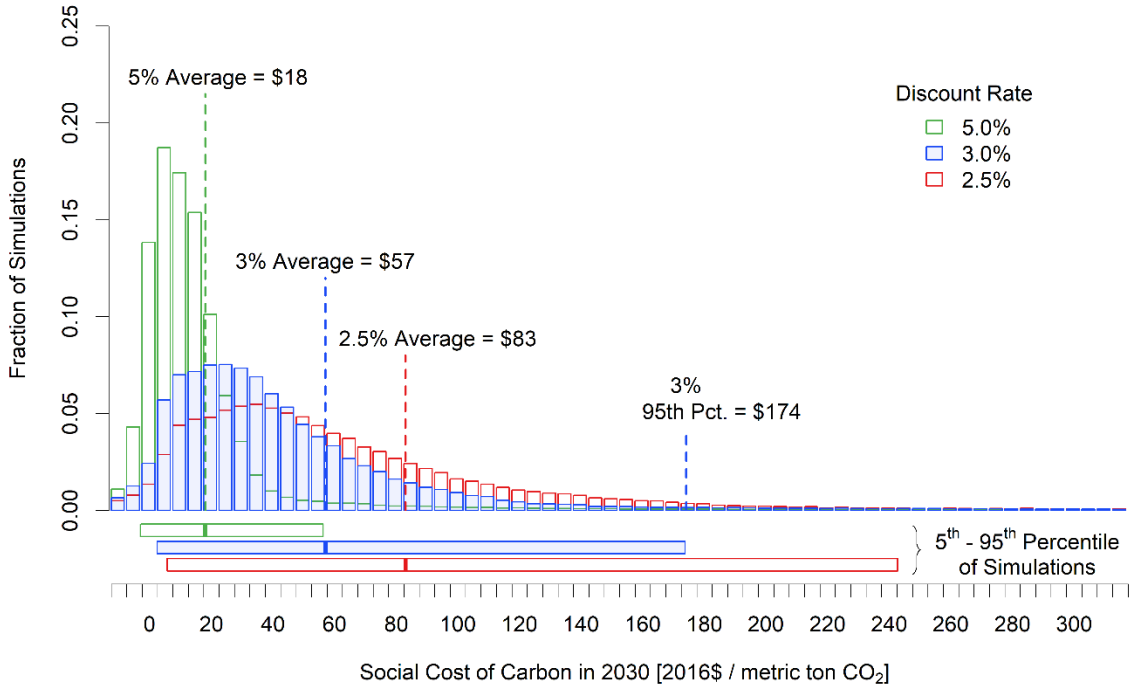

Figure 1. Frequency Distribution of SC-CO_2 Estimates for 2030[4]

In addition, the interim SC-CO_2 estimates presented in Table 1 have a number of other limitations. First, the current scientific and economic understanding of discounting approaches suggests discount rates appropriate for intergenerational analysis in the context of climate change are likely to be less than 3 percent, near 2 percent or lower (IWG 2021). Second, the IAMs used to produce these interim estimates do not include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature and the science underlying their "damage functions" – i.e., the core parts of the IAMs that map global mean temperature changes and other physical impacts of climate change into economic (both market and nonmarket) damages – lags behind the most recent research. For example, limitations include the incomplete treatment of catastrophic and non-catastrophic impacts in the integrated assessment models, their incomplete treatment of adaptation and technological change, the incomplete way in which inter-regional and intersectoral linkages are modeled, uncertainty in the extrapolation of damages to high temperatures, and inadequate representation of the relationship between

[4] Although the distributions and numbers in Figure are based on the full set of model results (150,000 estimates for each discount rate), for display purposes the horizontal axis is truncated with 0.78 percent of the estimates falling below the lowest bin displayed and 3.64 percent of the estimates falling above the highest bin displayed.

the discount rate and uncertainty in economic growth over long time horizons. Likewise, the socioeconomic and emissions scenarios used as inputs to the models do not reflect new information from the last decade of scenario generation or the full range of projections.

The modeling limitations do not all work in the same direction in terms of their influence on the SC-CO_2 estimates. However, as discussed in the February 2021 TSD, the IWG has recommended that, taken together, the limitations suggest that the interim SC-CO_2 estimates used in this technical memo likely underestimate the damages from CO_2 emissions. In particular, the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (IPCC 2007), which was the most current IPCC assessment available at the time when the IWG decision over the ECS input was made, concluded that SC-CO_2 estimates "very likely…underestimate the damage costs" due to omitted impacts. Since then, the peer-reviewed literature has continued to support this conclusion, as noted in the IPCC's Fifth Assessment report (IPCC 2014) and other recent scientific assessments (e.g., IPCC 2018, 2019a, 2019b; U.S. Global Change Research Program (USGCRP) 2016, 2018; and National Academies 2016b, 2019). These assessments confirm and strengthen the science, updating projections of future climate change and documenting and attributing ongoing changes. For example, sea level rise projections from the IPCC's Fourth Assessment report ranged from 18 to 59 centimeters by the 2090s relative to 1980-1999, while excluding any dynamic changes in ice sheets due to the limited understanding of those processes at the time (IPCC 2007). A decade later, the Fourth National Climate Assessment projected a substantially larger sea level rise of 30 to 130 centimeters by the end of the century relative to 2000, while not ruling out even more extreme outcomes (USGCRP 2018). The February 2021 TSD briefly previews some of the recent advances in the scientific and economic literature that the IWG is actively following and that could provide guidance on, or methodologies for, addressing some of the limitations with the interim SC-CO_2 estimates. EPA has reviewed and considered the limitations of the models used to estimate the interim SC-GHG estimates, and concurs with the February 2021 TSD's assessment that, taken together, the limitations suggest that the interim SC-CO_2 estimates likely underestimate the damages from CO_2 emissions. The IWG, of which EPA is a member, is currently working on a comprehensive update of the SC-GHG estimates taking into consideration recommendations from the National Academies of Sciences, Engineering and Medicine, recent scientific literature, and public comments received on the February 2021 TSD.

Table 2 shows the estimated monetary value of the estimated changes in CO_2 emissions expected to occur over 2023-2042 for the proposed FIP for the 2015 ozone NAAQS, the more-stringent alternative, and the less-stringent alternative. EPA estimated the dollar value of the CO_2-related effects for each analysis year between 2023 and 2042 by applying the SC-CO_2 estimates, shown in Table 1, to the estimated changes in CO_2 emissions in the corresponding year under the regulatory options. EPA then calculated the present value and annualized benefits from the perspective of 2022 by discounting each year-specific value to the year 2022 using the same discount rate used to calculate the SC-CO_2.[5]

[5]According to OMB's Circular A-4 (2003), an "analysis should focus on benefits and costs that accrue to citizens and residents of the United States", and international effects should be reported separately. Circular A-4 also reminds analysts that "[d]ifferent regulations may call for different emphases in the analysis, depending on the nature and complexity of the regulatory issues." To correctly assess the total climate damages to U.S. citizens and residents, an analysis must account for all the ways climate impacts affect the welfare of U.S. citizens and residents, including how U.S. GHG mitigation activities affect mitigation activities by other countries, and spillover effects from climate action elsewhere. The SC-GHG estimates used in regulatory analysis under revoked E.O. 13783 were a limited approximation of some of the U.S. specific climate damages from GHG emissions (e.g., \$7/mtCO_2 (2016 dollars) and \$9/mtCO_2 using a 3% discount rate for emissions occurring in 2023 and 2042, respectively). Applying the same estimate (based on a 3% discount rate) to the CO_2 emission reduction expected under the proposed option analyzed in this memorandum would yield benefits from climate impacts of \$1.5 million in 2023, increasing to \$232 million in 2042. However, as discussed at length in the February 2021 TSD, these estimates are an underestimate of the benefits of CO_2 mitigation accruing to U.S. citizens and residents, as well as being subject to a considerable degree of uncertainty due to the manner in which they are derived. In particular, as discussed in this memo, EPA concurs with the assessment in the February 2021 TSD that the estimates developed under revoked E.O. 13783 did not capture significant regional interactions, spillovers, and other effects and so are incomplete underestimates. As the U.S. Government Accountability Office (GAO) concluded in a June 2020 report examining the SC-GHG estimates developed under E.O. 13783, the models "were not premised or calibrated to provide estimates of the social cost of carbon based on domestic damages" (U.S. GAO 2020, p. 29). Further, the report noted that the National Academies found that country-specific social costs of carbon estimates were "limited by existing methodologies, which focus primarily on global estimates and do not model all relevant interactions among regions" (U.S. GAO 2020, p. 26). It is also important to note that the SC-GHG estimates developed under E.O. 13783 were never peer reviewed, and when their use in a specific regulatory action was challenged, the U.S. District Court for the Northern District of California determined that use of those values had been "soundly rejected by economists as improper and unsupported by science," and that the values themselves omitted key damages to U.S. citizens and residents including to supply chains, U.S. assets and companies, and geopolitical security. The Court found that by omitting such impacts, those estimates "fail[ed] to consider…important aspect[s] of the problem" and departed from the "best science available" as reflected in the global estimates. *California v. Bernhardt*, 472 F. Supp. 3d 573, 613-14 (N.D.Cal. 2020). EPA continues to center attention in this memorandum on the global measures of the SC-GHG as the appropriate estimates given the flaws in the U.S. specific estimates, and as necessary for all countries to use to achieve an efficient allocation of resources for emissions reduction on a global basis, and so benefit the U.S. and its citizens.

Table 2. Estimated Climate Benefits from Changes in CO_2 Emissions 2023 - 2042 (Millions of 2016$)[a]

Regulatory Alternative	Year	Discount Rate and Statistic			
		5% Average	3% Average	2.5% Average	3% 95th Percentile
Proposed Rule	2023	3	11	17	34
	2024	277	935	1,379	2,798
	2025	568	1,894	2,784	5,678
	2026	638	2,106	3,086	6,324
	2027	710	2,324	3,395	6,991
	2030	887	2,828	4,098	8,550
	2035	771	2,336	3,333	7,125
	2042	600	1,710	2,396	5,253
More-Stringent Alternative	2023	6	21	32	64
	2024	293	987	1,456	2,954
	2025	597	1,990	2,926	5,967
	2026	674	2,225	3,261	6,683
	2027	754	2,467	3,605	7,423
	2030	883	2,817	4,081	8,516
	2035	776	2,352	3,356	7,172
	2042	587	1,674	2,345	5,142
Less-Stringent Alternative	2023	3	11	16	33
	2024	146	493	728	1,476
	2025	298	994	1,461	2,980
	2026	422	1,395	2,044	4,188
	2027	553	1,809	2,644	5,443
	2030	809	2,581	3,739	7,802
	2035	737	2,233	3,187	6,811
	2042	557	1,586	2,223	4,873

[a] Climate benefits are based on changes (reductions) in CO_2 emissions and are calculated using four different estimates of the social cost of carbon (SC-CO_2) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate). We emphasize the importance and value of considering the benefits calculated using all four SC-CO_2 estimates. As discussed in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021), a consideration of climate benefits calculated using discount rates below 3 percent, including 2 percent and lower, are also warranted when discounting intergenerational impacts.

Table 3 and Table 4 show the total annualized monetary values associated with changes in CO_2 emissions for the three regulatory options. EPA annualized monetary value estimates to enable consistent reporting across benefit categories (*e.g.*, benefits from reduction in NOx emissions). The annualized values for 2023-27 for the proposed rule are $442 million and $444 million, using discount rates for annualization of 3 and 7 percent, respectively. The annualized values for 2023-42 for the proposed rule are $670 million and $673 million, using discount rates of 3 and 7 percent, respectively.

Table 3. Estimated Total Annualized Climate Benefits (2023-27) from Changes in CO_2 Emissions (Millions of 2016$)

Regulatory Option	5% Discount Rate	3% Discount Rate	2.5% Discount Rate	3% Discount Rate 95th Percentile
3% Discount Rate for Annualization				
Proposal	442	1,339	1,964	4,020
More-Stringent Alternative	467	1,417	2,078	4,253
Less-Stringent Alternative	285	862	1,264	2,589
7% Discount Rate for Annualization				
Proposal	444	1,206	1,769	3,620
More-Stringent Alternative	470	1,276	1,872	3,830
Less-Stringent Alternative	285	772	1,131	2,317

Table 4. Estimated Total Annualized Climate Benefits (2023-42) from Changes in CO_2 Emissions (Millions of 2016$)

Regulatory Option	5% Discount Rate	3% Discount Rate	2.5% Discount Rate	3% Discount Rate 95th Percentile
3% Discount Rate for Annualization				
Proposal	670	1,554	2,239	4,715
More-Stringent Alternative	678	1,575	2,269	4,776
Less-Stringent Alternative	584	1,347	1,938	4,091
7% Discount Rate for Annualization				
Proposal	673	1,121	1,619	3,396
More-Stringent Alternative	685	1,142	1,650	3,459
Less-Stringent Alternative	574	951	1,371	2,884

We invite comment on this memorandum.[6] We note that the methodology underlying the SC-CO_2 estimates used in this memorandum has been subject to public comment in the context of dozens of proposed rulemakings as well as in a dedicated public comment period in 2013. Further, the monetized climate benefits presented in this memorandum are not a part of the technical or legal basis of the proposed action for which the RIA was prepared. Rather, the EPA in this action is proposing requirements

[6] In Section IX of the preamble, we stated, "We request comment on how to address the climate benefits and other categories of non-monetized benefits of the proposed rule." This request for comment was made during the pendency of the preliminary injunction. *See Louisiana v. Biden*, No. 21-cv-01074-JDC-KK (W.D. La., Feb. 11, 2022). We note that the public remains free to submit comments related to non-monetized climate benefits. In any case, as explained in the preamble, RIA, and this memorandum, all climate benefits that may result from this proposed action, whether monetized or not, are not relied upon as part of the technical or legal basis for this rulemaking.

to reduce emissions of nitrogen oxides (NO_X), as necessary to eliminate significant contribution and interference with maintenance of the 2015 ozone NAAQS at downwind receptors pursuant to Clean Air Act section 110(a)(2)(D)(i)(I). The monetized benefits associated with projected reductions in greenhouse gas emissions that may result from the proposed rule are presented solely for purposes of compliance with E.O. 12866 and to present the public with information regarding the full scope of potential benefits of the proposed action. However, as is generally the case with any analytical methods, data, or results associated with RIAs, we invite the public to comment on this memorandum, which is an addendum to the RIA. The EPA welcomes the opportunity to continually improve its understanding through public input on the analytical issues associated with the presentation of anticipated costs, benefits, and other impacts of its actions, as done through RIAs. We note that there is an ongoing interagency process to update the SC-GHG estimates, and there will be further opportunity to provide public input on the SC-GHG methodology through that process.[7]

[7] For example, EPA, on behalf of the IWG, published a Federal Register notice on January 25, 2022, to solicit public nominations of scientific experts for the upcoming peer review the forthcoming update. *See* https://www.federalregister.gov/documents/2022/01/25/2022-01387/request-for-nominations-of-experts-for-the-review-of-technical-support-document-for-the-social-cost. EPA has a webpage where additional information regarding the peer review process will be posted as it becomes available: https://www.epa.gov/environmental-economics/scghg-tsd-peer-review. There will be a separate Federal Register notice for the public comment period on the forthcoming SC-GHG technical support document once it is released.