Technical Support Document (TSD)
for the Final Revised CSAPR Update for the 2008 Ozone NAAQS

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Ozone Transport Policy Analysis
Final Rule TSD

U.S. Environmental Protection Agency
Office of Air and Radiation
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The analysis presented in this document supports the EPA's final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone NAAQS (Revised CSAPR Update). This TSD includes analysis to help quantify upwind state emissions that significantly contribute to nonattainment or interfere with maintenance of the 2008 ozone NAAQS in downwind states and quantification of emission budgets (i.e., limits on emissions) and the resulting effects on air quality. The analysis is described in Sections VI and VII of the preamble to the rule. This TSD also broadly describes how the EPA used historical data and the Integrated Planning Model (IPM) to inform air quality modeling, budget setting, and policy analysis aspects of this rule. Finally, this TSD includes an assessment on the effects of ozone concentrations on forest health. This TSD is organized as follows:

A. Background on EPA's Analysis to Quantify Emissions that Significantly Contribute to Nonattainment or Interfere with Maintenance of the 2008 Ozone NAAQS
B. Using Engineering Analytics and Integrated Planning Model (IPM) to Assess Air Quality Modeling, EGU NOx Mitigation Strategies, and Policy Impacts
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A. Background on EPA's Analysis to Quantify Emissions that Significantly Contribute to Nonattainment or Interfere with Maintenance of the 2008 Ozone NAAQS

In the preamble, EPA describes the 4-Step Good Neighbor Framework that it is applying to identify upwind states' emissions that significantly contribute to nonattainment or interfere with maintenance with respect to the 2008 ozone National Ambient Air Quality Standard (NAAQS) in other states and to implement appropriate emission reductions. This framework was used in the original CSAPR rulemaking to address interstate transport with respect to the 1997 ozone NAAQS and the 1997 and 2006 PM2.5 NAAQS and was also used in the 2016 CSAPR Update to address interstate transport with respect to the 2008 ozone NAAQS.

The first step of the Good Neighbor Framework uses air quality analysis to identify nonattainment and maintenance receptors for the 2008 ozone NAAQS. The second step of the framework uses further air quality analysis to identify upwind states whose ozone pollution contributions to these monitoring sites meet or exceed a specified threshold and therefore merit further analysis. See section V of the preamble for details on applying these steps with respect to interstate emissions transport for the 2008 ozone NAAQS.

The third step in the Good Neighbor Framework quantifies upwind state emissions that significantly contribute to nonattainment or interfere with maintenance of the 2008 ozone NAAQS at the downwind receptors, and identifies the electricity generating unit (EGU) NO_X emission budgets and/or non-EGU emissions reduction for each state that represent the reduction of these emissions levels. See section VI of the preamble with respect to interstate emissions transport for the 2008 ozone NAAQS. Finally, the fourth step of the Good Neighbor Framework implements the emission budgets in each state through the CSAPR NO_X ozone season allowance trading program or other enforceable mechanism. See section VII of the preamble for details on implementation for this rule.

This TSD primarily addresses step three of the Good Neighbor Framework related to EGU emissions as well as to the effects on air quality of both EGU and non-EGU emissions reductions. In order to establish EGU NO_X emissions budgets for each linked upwind state, EPA first identifies various possible uniform levels of NOx control stringency based on available EGU NO_X control strategies and represented by cost thresholds.[1] The EGU emission reductions pertaining to each level of control stringency are derived using historical data, engineering analyses, and EPA's integrated planning model (IPM) for the power sector as described in sections B and C of this TSD. The adjusted historical data and the model data are combined in order to quantify a series of potential EGU NO_X emission budgets for each linked upwind state at each level of uniform NO_X control stringency. A similar assessment for one scenario was done for non-EGUs. Next, EPA uses the ozone Air Quality Assessment Tool (AQAT) to estimate the air quality impacts of the upwind state emissions reductions on downwind ozone pollution levels for each of the assessed cost threshold levels. Specifically, EPA looks at the magnitude of air quality improvement at each receptor at each level of control, it also examines whether receptors change status (shifting from either nonattainment to maintenance, or from maintenance to attainment), and looks at the individual contributions of each state to each of its receptors. See section D in this TSD for discussion of the development and use of the ozone AQAT.

Finally, the EPA uses this air quality information within the multi-factor test, along with NO_X reduction potential, cost, and other considerations to select a particular level of uniform

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[1] See the EGU NOx Mitigation Strategies Final Rule TSD

NO_X control stringency that addresses each state's significant contribution to nonattainment and interference with maintenance (see Section VI.D of the preamble for additional information).

In this TSD, EPA assesses the EGU NO_X mitigation potential for all states in the contiguous U.S. EPA assessed the air quality impacts for all monitors in the contiguous U.S. from emission reductions that met the criteria for developing air quality contribution estimates. In applying the multi-factor test for purposes of identifying the appropriate level of control, the EPA evaluated NO_X reductions and air quality improvements at the four receptors from the two home states and the 12 upwind states that were linked to downwind receptors in step two of the 4-Step Good Neighbor Framework. The 12 upwind linked states are listed in Table A-1 below.

Table A-1. Upwind States Evaluated in the Multi-factor Test

Ozone Season NO_X	
Illinois	New Jersey
Indiana	New York
Kentucky	Ohio
Louisiana	Pennsylvania
Maryland	Virginia
Michigan	West Virginia

B. Using the Engineering Analytics Tool and the Integrated Planning Model (IPM) to Assess Air Quality Modeling, EGU NOx Mitigation Strategies, and Policy Impacts

Similar to the final CSAPR Update, EPA relied on adjusted historical data (engineering analytics) and its power sector modeling platform using IPM as part of the process to quantify significant contribution at step three within the 4-Step Good Neighbor Framework. Historical data were adjusted through the engineering analytics tool and used along with IPM to analyze the ozone season NO_X emission reductions available from EGUs at various uniform levels of NO_X control stringency, represented by cost per ton, in each upwind state. Finally, IPM was used to evaluate compliance with the rule and the rule's regulatory control alternatives (i.e., compliance with the emission budgets, with a more stringent alternative, and with a less stringent alternative). EPA also used its engineering analytics tool and IPM projections to perform air quality assessment and sensitivity analysis for steps 1 and 2.

The engineering analytics tool uses the latest historical representative emissions and operating data reported under 40 CFR part 75 by covered units (which were 2019 ozone-season data at the time of this analysis).[2] It is a tool that builds estimates of future unit-level and state-level emissions based on exogenous changes to historical heat input and emissions data reflecting fleet changes known to occur subsequent to the last year of available data. See Section C. *Calculating Budgets from Historical Data and IPM Analysis* for a detailed description of the engineering analytics tool.

IPM is a multiregional, dynamic, deterministic linear programming model of the U.S. electric power sector that EPA uses to analyze cost and emissions impacts of environmental

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[2] As explained in preamble section VII.B, EPA did not use 2020 data as a representative historical year due to the global COVID-19 pandemic.

policies.[3] All IPM cases for this rule included representation of the Title IV SO_2 cap and trade program; the NO_X SIP Call; the CSAPR and CSAPR Update regional cap and trade programs; consent decrees and settlements; and state and federal rules as listed in the IPM documentation referenced above.

Application of the 4-Step Good Neighbor Framework requires robust data collection, IPM modeling and engineering analytics is time consuming. Rather than freezing all IPM and engineering analytic data sets at the outset of EPA's analysis for the rule, the EPA allowed for ongoing improvement of the relied-upon EGU data. As a result, each step of EPA's analysis for the final rule is informed by the best available data at the time the analysis was conducted.

In the power sector modeling done for this rule, the EPA needed to quantify emissions for three different analytic purposes. The first purpose was to provide future base case EGU emissions for input to air quality modeling to identify nonattainment and maintenance receptors and quantify interstate contribution to inform steps 1 and 2 of the 4-Step Good Neighbor Framework. This base case incorporated the most important fleet changes and retrofits identified through comments up to Fall of 2019 using the National Electricity Energy Data System (NEEDS) EGU inventory, January 8, 2020 version. The version of the NEEDS file reflects EGU fleet updates through November 2019.[4]

The second purpose was to construct an illustrative base case and control case to study the potential cost and reduction potential of different uniform technology scenarios. This set of cases is referred to as the "Illustrative Cases." These illustrative cases are primarily cost threshold runs that EPA performed where the agency would first adjust the base case to reflect the relevant control technologies being considered and would then perform a sensitivity where a dollar per ton price constraint (e.g., $1,600 per ton) was applied to that adjusted base case to estimate the additional reductions to be expected from generation shifting at a dollar per ton level commensurate with the technology operating cost.

The third purpose was to estimate system impacts of the final rule and confirm the impact of implementing the state emissions budgets in a region-wide trading program. This set of cases is referred to as the "Final Policy Cases." For the Final Policy Cases, the EPA applied the state emission budgets and corresponding state and regional caps to the same base case used in the illustrative cases. EPA also performed a "less stringent" and "more stringent" control scenario policy case using lower and higher state emission budgets respectively. The "Final Cases" were used to inform the cost and benefits of this rulemaking, as described in the Regulatory Impact Analysis, or RIA, for this rule.

Table B-1 below summarizes the various IPM runs conducted and Appendix C provides further details on each of these scenarios.

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[3] See "Documentation for EPA's Power Sector Modeling Platform v6 using January 2020 Reference Case". Available at https://www.epa.gov/airmarkets/epas-power-sector-modeling-platform-v6-using-ipm-january-2020-reference-case.

[4] https://www.epa.gov/airmarkets/national-electric-energy-data-system-needs-v6

Table B-1. Summary of Sets of Scenarios.

	Air Quality Modeling Base Case	Illustrative Cases	Final Policy Cases
Scenarios Run	Base Case (IPM) Base Case Sensitivity (Engineering Analytics)	Base Case (IPM) Base Case (Engineering Analytics) Uniform Control/Cost Threshold (IPM and Engineering Analytics)	Policy Cases (IPM)
What Analysis Each Set of Runs Informs	Base Case air quality modeling to identify nonattainment and maintenance receptors and estimate upwind contributions (steps 1 and 2)	Development of a set of state emission budgets for each cost threshold (step 3)	RIA analysis to gauge system impacts when budgets are implemented through a trading program (step 4)
EGU Updates Captured in Each Set of Runs	Updates as of November 2019 for IPM scenarios, and as of December 2020 for Engineering Analytic Sensitivity	Updates as of June 30, 2020 for IPM scenarios and December 2020 for Engineering Analytic scenarios	Updates as of December 2020

For the "Illustrative Case" IPM runs, the EPA modeled the emissions that would occur within each state in a Base Case. The EPA then designed a series of IPM runs that imposed increasing cost thresholds representing uniform levels of NO_X controls and tabulated those projected emissions for each state at each cost level. The EPA has referred to these runs as "Cost Threshold Runs" and these tabulations, when combined with adjusted historical data, as "cost curves."[5] The cost curves report the remaining emissions at each cost threshold after the state has made emission reductions that are available up to the particular cost threshold analyzed.

In each Cost Threshold run, the EPA applied the applicable ozone-season cost level to all fossil-fuel-fired EGUs with a capacity greater than 25 MW in all states, though only the estimates for the four receptors, the two "home states" for those receptors, and the 12 linked

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[5] These projected state level emissions and heat input for each "cost threshold" run are presented in several formats. The IPM analysis outputs available in the docket contain a "state emissions" file for each analysis. The file contains two worksheets. The first is titled "all units" and shows aggregate emissions for all units in the state. The second is titled "all fossil > 25MW" and shows emissions for a subset of these units that have a capacity greater than 25 MW. The 2021 emissions and heat input in the "all fossil > 25 MW" worksheet is used to derive the generation shifting component of the state emission budgets for each upwind state at the cost thresholds.

states affect the results in Step 3. As described in the EGU NO_X Mitigation Strategies Final Rule TSD, because of the time required to build advanced pollution controls, the model was prevented from building any new post-combustion controls, such as SCR or SNCR, before 2025, in response to the cost thresholds.[6] Similarly, the model was not enabled to build incremental new units in that time frame. In response to the ozone-season NO_X cost, the modeling allows turning on idled existing SCR and SNCR, optimization of existing SCR, shifting generation to lower-NO_X emitting EGUs, and adding or upgrading NO_X combustion controls (such as state-of-the-art low NO_X burners (LNB)) in 2021/2022. In this TSD, we refer to state-of-the-art combustion controls, or SOA CC, generally, as combustion controls, or LNB).

In these scenarios, EPA imposed cost thresholds of $500, $1,600, $1,800, $3,900, $5,800, $9,600 per ton of ozone season NO_X. See Preamble Section VI for a discussion of how the cost thresholds were determined. Table B-2 below summarizes the reduction measures that are broadly available at various cost thresholds.

Table B-2. Reduction strategies available to EGUs at each cost threshold.

Cost Threshold ($ per ton Ozone-Season NO_X)	**Reduction Options**
$500	-Generation shifting
$1,600	-Above option; and -Retrofitting state-of-the-art combustion controls; -Optimizing idled SCRs (to 0.08 lb/MMBtu); -Optimizing operating SCRs (to 0.08 lb/MMBtu);
$1,800	-Above options; and -Optimizing operating SNCRs[7] ($3,900 for optimizing idled SNCR)
$5,800	-Above options; and -Installing SNCR on certain coal units lacking post-combustion retrofit
$9,600	-Same as above options; and -Installing SCR on certain coal units lacking SCR post-combustion controls (rather than SNCR).

For both Engineering analytics and IPM:

- At $500/ton:
  - Engineering Analytics – no change.
  - IPM - cost of $500 per ton applied to base case for EGUs > 25 MW.
- At $1,600/ton:

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[6] IPM results do include certain newly built post-combustion NO_X control retrofits in base case modeling, cost curve runs, and remedy runs. These pre-2020 retrofits do not reflect any controls installed in response to the rule, but instead represent those that are already announced and/or under construction and expected to be online by 2021, or controls that were projected to be built in the base case in response to existing consent decree or state rule requirements.

[7] As explained in the preamble section VI.B, EPA notes that this technology becomes widely available at $1,800 per ton. For purposes of assessing generation shifting available at this technology level's commensurate cost, EPA relies on its $1,600 per ton IPM analysis.

  - Engineering Analytics – If 2019 adjusted baseline rate was greater than 0.08 lb/MMBtu for SCR controlled units, that rate and corresponding emissions were adjusted down to 0.08 lb/MMBtu starting in 2021; for units with LNB upgrade potential and an adjusted historical rate greater than 0.199 lb/MMBtu, their rates were adjusted downwards to 0.199 lb/MMBtu starting in 2022.
  - IPM - cost of $1,600 per ton applied for EGUs > 25 MW; units with existing SCRs have their emission rates lowered to the lower of their mode 4 NO_X rate in NEEDS and the "widely achievable" optimized emissions rate of 0.08 lbs/MMBtu. [8]
- At $1,800/ton:
  - Engineering Analytics – Same as $1,600/ton; additionally, units with SNCRs were given their mode 2 NOx rates if they were not already operating at that level or better in 2019.
  - IPM – Same as $1,600/ton;

- At $5,800/ton:
  - Engineering Analytics – Same as $1,800/ton; additionally, coal units greater than 100 MW and lacking a post-combustion control were given a 25% reduction to adjusted historical baseline emissions starting in 2024 to reflect SNCR installation.[9]
  - IPM – Same as $1,800/ton; additionally, coal units greater than 100 MW and lacking a post combustion control were given a 25% reduction from their mode 2 rate reflecting SNCR installation, starting in model run year 2025.[10] Cost of $5,800 per ton applied for EGUs > 25 MW. Additionally, units with idled SNCRs were identified as units equipped with SNCR and mode 2 NO_X rates in NEEDS greater than 0.30 lbs/MMBtu. These units were given NO_X rates 25% lower to reflect SNCR operation.

- At $9,600/ton:
  - Engineering Analytics – Same as $1,800/ton; additionally, coal units greater than 100 MW and lacking a SCR were given an emission rate equal to the greater of a reduction of 90% or 0.07 lb/MMBtu reflecting SCR installation starting in 2024.
  - IPM – Same as $3,900/ton; additionally, coal units greater than 100 MW and lacking SCR were assigned a mode four emission rate of 0.07 lb/MMBtu reflecting SCR installation starting in model run year 2025. Cost of $9,600 per ton applied for EGUs > 25 MW.

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[8] The mode 4 NO_X rate, as described in Chapter 3 of the Documentation for EPA Base Case v.6 Using Integrated Planning Model, represents post-combustion controls operating and state-of-the-art combustion controls, where applicable. For units determined to be operating their SCR, the rate is typically equal to the unit's rate reported in previous year ETS data. For units not operating their SCRs, the mode 4 rate is calculated as described in Attachment 3-1 of the Documentation for EPA Base Case v.6 Using Integrated Planning Model available at https://www.epa.gov/airmarkets/ipm-v6-power-system-operation-assumptions-attachment-3-1-nox-rate-development-epa.

[9] As described in preamble section VI.C, EPA does not believe these controls to be available on a regional scale until 2025. However, the EPA shows their impact from 2024 onwards in its engineering analysis. For its IPM analysis, there is no model run year for 2024, so 2025 is the first year for which they can be assumed.

[10] EPA's Power Sector Model v.6 using IPM does not have a 2024 model run year.

As described in preamble section VI.B, the EPA limited its assessment of generation shifting to reflect shifting only to other EGUs within the same state as a proxy for generation shifting that could occur during the near-term implementation timeframe of the rule. EPA did this by limiting state generation in each Cost Threshold run to not go below the level in its respective Base Case. EPA also limited the potential for any new build in response to the price signal in the near term as it was interested in capturing generation shifting among the existing fleet.

Section C.1-3 of this TSD describes how state emissions budgets were calculated using a combination of historical data and data from the IPM cost threshold cases. Once these budgets were calculated, EPA used the budgets for covered states to conduct IPM Final Policy Cases to investigate the impact of compliance with the budgets calculated from the $500, $1,800, $9,600 per ton cases. These cases reflect a less stringent scenario, the final policy scenario, and a more stringent scenario. Specifically, the budgets informed by the Illustrative $1,800 per ton Cost Threshold case were used for the final policy scenario, and the budgets informed by the Illustrative $500 and $9,600 per ton cost threshold cases informed the less and more stringent scenarios. These scenarios were used to inform the RIA.

To model these scenarios in IPM, EPA used the calculated state emissions budget and assurance levels (121% of the state emission budget) to set state and regional ozone-season NO_X emissions limits. Additionally, EPA assumed a starting bank of allowances equal to 21% of the sum of the 12 states’ budgets. States could individually emit up to their assurance levels in each run year, and collectively could not have emissions exceeding the sum of their regional budget and banked allowances in each run year. In the final policy scenario and the more stringent scenario, units with existing operating SCRs were assumed to operate them at the lower of their mode 4 NO_X rate in NEEDS and the “widely achievable” emissions rate of 0.08 lb/MMBtu, as EPA determined this was a cost-effective mitigation strategy. Additionally, for these same two scenarios, coal units with identified combustion control upgrade potential were assumed to upgrade to state-of-the-art combustion controls. In all scenarios, the model provided the units the option to retrofit with post-combustion controls. While the EPA conservatively limited generation shifting in developing the state emission budgets, through use of state-level generation constraints, the EPA believes that generation shifting may occur broadly among states as a compliance mechanism and so removed that constraint for the IPM Final Policy Cases reflecting program implementation.

C. Calculating Budgets from Historical Data and IPM Analysis

As described in Section VII.B of the preamble, similar to CSAPR Update, the EPA determined it was appropriate to calculate state emission budgets by combining historical emissions and heat input data with projections from IPM to derive state emission budgets. Section VII.B notes there are three primary steps in this process: 1) EPA determines a future year baseline using historical data, 2) EPA adjusts that baseline to reflect the combustion and post-combustion control mitigation measures deemed cost-effective at a given cost threshold, and 3) EPA factors in emission reduction potential from generation shifting at a cost threshold commensurate with that mitigation technology's control operation cost. Similar to CSAPR Update, in this final rule the EPA calculated state budgets with the following formula:

$$\textbf{2021 State OS NO}_{\textbf{X}}\textbf{ Budget} = \text{2021 State OS Baseline Heat Input} * [2021\ State\ OS\ NO_X\ Emissions\ Rate - (2021\ IPM\ Base\ Case\ OS\ NO_X\ Emissions\ Rate\ -\ \text{2021 IPM Cost Threshold}\ OS\ NO_X\ \text{Emissions Rate})]$$[11]

The first two variables in the equation are derived from historical data and are the primary determinants of states' emissions budgets. They are described in sections C.1 and C.2 below. The last two variables are identified through IPM analysis and described in section C.3 below.[12] In section C.4, EPA discusses variability limits and RIA scenarios.

1. Calculating 2021-2025 Engineering Baseline for NOx (from adjusted historical data)

The underlying data and calculations described below can be found in the workbook titled (Appendix A – Final Rule State Emission Budget Calculations and Engineering Analytics). They are *also available in the docket and on the EPA website.*

EPA starts with 2019 reported, seasonal, historical NOx emissions and heat input data for each unit.[13] This reflects the latest representative owner/operator reported data available at the time of EPA analysis.[14] The NO$_x$ emissions data for units that report data to EPA under the Acid Rain Program (ARP), the Cross-State Air Pollution Rule (CSAPR) and CSAPR Update Rule are aggregated to the summer/ozone season period (May-September). Because the unit-level NOx emissions for the summer/ozone-season period are relevant to determining ozone-season emissions budgets, those files are shown in the "unit 2021" through "unit 2025" sheets in the "Appendix A: Final Rule State Emission Budget Calculations and Engineering Analytics" file accompanying this document.[15] In that file, unit-level details such as facility name, unit ID, unit type, capacity, etc. are shown in columns A through H of the "unit 2021" through "unit 2025"

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[11] The year in the formula changes for each year of budget calculation.

[12] Given the proximity of the first implementation year to the analytics for this rulemaking and its promulgation, EPA determined the use of this budget setting approach provided the most precision and expediency for this rulemaking.

[13] "Seasonal" refers to the ozone-season program months of May through September.

[14] Preamble section VII.B addresses EPA's consideration of 2020 reported data as representative data.

[15] The EPA notes that historical unit-level ozone season EGU NO$_x$ emission rates are publicly available and quality assured data. The data are monitored using continuous emissions monitors (CEMs) or other monitoring approaches available to qualifying units under 40 CFR part 75 and are reported to the EPA directly by power sector sources.

worksheets. Reported historical data for these units such as historical emissions, heat input, generation, etc. are shown in columns I through L. The 2019 historical emissions value is in column I. The assumed future year baseline emissions estimate (e.g., 2021-2025) is shown in column U, and reflects either the same emissions level as that observed in 2019, or a modification of that value based on changes expected to the operational or pollution control status of that unit.[16] These modifications are made due to:

a. *Retirements* - Emissions from units with upcoming confirmed retirement dates prior to that designated year are adjusted to zero. Retirement dates are identified through a combination of sources including EIA Form 860, utility-announced retirements, stakeholder and commenter feedback provided to EPA, and the National Electricity Energy Data System (NEEDS) December 2020 file. The impact of retirements on emissions is shown in column M. The retiring units are flagged in column N.[17]

	2019	Future Year (e.g., 2021)
Unit x	10,000 MMBtu x .2 lb/MMBtu = 1 ton	*0 MMBtu* x .2 lb/MMBtu = *0 ton*

b. *Coal to Gas Conversion* – Emissions from coal units with scheduled conversions to natural gas fuel use by the designated future year are adjusted to reflect reduced emission rates associated with natural gas. To reflect a given unit's conversion to gas, that unit's future emission rates for NO_x are assumed to be half of its 2019 coal-fired emission rates while utilization levels are assumed to remain the same.[18] Therefore, the future year estimated emissions for these converting units are expected to be half of 2019 levels for NO_x. Units expected to convert to gas are flagged using EIA Form 860, NEEDS June 2020, and stakeholder feedback. The impact of coal to gas conversion for the future year is shown in column Q, flagged in column R. The example below pertains to NO_x emission estimates.

	2019	Future Year (e.g., 2021)
Unit x	10,000 MMBtu x .2 lb/MMBtu = 1 ton	10,000 MMBtu x *.1 lb/MMBtu* = .5 *ton*

c. *Retrofits* – Emissions from units with scheduled SCR or SNCR retrofits are adjusted to reflect the emission rates expected with new SCR installation (0.075 lb/MMBtu of NO_x) and new SNCR (~25% representative decrease in emission rate) and are assumed to operate at the same 2019 utilization levels.[19] These emission rates were multiplied by the affected unit's 2019 heat input to estimate the future year emission level. The impact of post-combustion control retrofits on future year emissions assumptions is shown in column S, flagged in column T.

For SNCR:

	2019	Future Year (e.g., 2021)

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[16] Based on data and changes known at time of analysis.

[17] EPA updated its inventory of units flagged as retiring in column N based on commenter input on the proposed rule and the latest data from EIA 860 and the PJM retirement tracker.

[18] This is consistent with NO_X rate change used in IPM. See "Documentation for EPA Base Case v.5.13 Using the Integrated Planning Model.", table 5-21.

[19] *Ibid.*

Unit x	10,000 MMBtu x .2 lb/MMBtu = 1 ton	10,000 MMBt*u* x *.15 lb/MMBtu* = .75 *ton*

For SCR:

	2019	Future Year (e.g., 2021)
Unit x	10,000 MMBtu x .2 lb/MMBtu = 1 ton	10,000 MMBt*u* x *.075 lb/MMBtu* = .375 *ton*

d. *Other* – EPA also made several unit-specific adjustments to 2019 emission levels to reflect forthcoming emission or emission rate requirements specified in consent decrees, BART requirements, and/or other revised permit limits. The impacts for future year emission assumptions are shown in column U, flagged in column V.[20]

e. *New Units* – Emissions for new units are identified in the “New units” worksheet. They reflect under-construction and/or permitted units greater than 25 MW that are expected to be in commercial operation by the designated future year. These assumed emission values for new units are reflected in column F and the online years are in column H. To obtain these emissions, EPA identified all new fossil-fired EGUs coming online after 2019 according to EIA Form 860 and in NEEDSv.6 December 2020. EPA then identified the heat rate and capacity values for these units using EIA Form 860, NEEDSv.6 December 2020 and stakeholder-provided data. Next, EPA identified the 2019 average seasonal capacity factor for similar units that came online between 2015-2019. EPA used these seasonal capacity factors (e.g., 65% for NGCC), the unit’s capacity, the unit’s heat rate, and the unit’s estimated NO_x rate to estimate future year emissions (capacity × capacity factor × number of hours in ozone season × heat rate × NO_x emission rate = NO_x emissions).[21,22]

	2019	Future Year (e.g., 2021)
Unit x	0 MMBtu x .0 lb/MMBtu = 0 ton	100 MW * .65 *(153x24) *8000 Btu/KWh *.01 lb/MMBtu = 9 tons

After completing these steps, EPA has unit-level and state-level future year baselines that originate from the most recently reported representative data (2019) and incorporate known EGU fleet changes.[23] The state-level file reflects a summation of the unit-level values and provides the

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[20] EPA checked its inventory of units impacted by consent decrees based on input provided by commenters at proposal. No units were determined to be impacted as described in the Allowance Allocation under the Revised CSAPR Update Final Rule TSD.

[21] Based on comment, EPA also incorporated new NGCC units that had received their regulatory approvals for construction according to EIA 860m (October 2020), had not reported starting construction by that time, but that were reporting planned commercial operation dates prior to the start of the 2023 or 2024 ozone season. Some of these units appeared to have begun construction post October 2020. Moreover, regardless of whether these new units come online as scheduled, EPA views their anticipated heat input, generation, and emissions as reflective of expected fleet behavior from total NGCC operation in response to fleet turnover and retirement of higher emitting units, and therefore they are included in the baseline.

[22] Emission rate data is informed by the NEEDS data and historical data for like units coming online in the last five years. See “2019 and 2020 new NGCC Data” worksheet in the “EGU Power Sector 2019 and 2020 data” file in the docket.

[23] As explained in preamble section VII.B, EPA did not consider recently available 2020 data totals as representative for future years due to the unique global Covid-19 pandemic impacting that year.

state-level heat input value used as the first variable in the emissions budget formula below. It also provides the starting value for the second variable (i.e., showing the future year baseline emission rate) before any mitigation technologies beyond the baseline are incorporated.[24]

$$\textbf{2021 State OS NO}_\textbf{X}\textbf{ Budget} = \text{2021 State OS Baseline Heat Input} * [2021\ State\ OS\ NO_X\ Emissions\ Rate - (2021\ IPM\ Base\ Case\ OS\ NO_X\ Emissions\ Rate - \text{2021 IPM Cost Threshold } OS\ NO_X \text{ Emissions Rate})]$$

2. <u>Estimating impacts of combustion and post combustion controls on state emission budgets</u>

Next, EPA evaluates the impact of the different combustion and post-combustion controls and establishes the impact on the state OS NOx Emission rate to complete the second variable in the equation above. Similar to the methodology above, EPA continued to adjust the historical data to reflect a future year with specific uniform control assumptions. However, these adjustments were to capture changes incremental to the baseline reflecting different uniform control measures. EPA applied these adjustments for analytical purposes to all states, but only the 12 linked states' adjustments are relevant for emission budgets finalized in this rule. Each of these adjustments is shown incrementally for the relevant mitigation technology in the "unit 2021" through "unit 2025" worksheets.

a. *SCR optimization* – Emissions from units with existing SCRs, but that operated at an emission rate greater than 0.08 lb/MMBtu in 2019, were adjusted downwards to reflect expected emissions when the SCR is operated to achieve a 0.08 lb/MMBtu emission rate. The 0.08 lb/MMBtu emission rate was identified as the emission rate that reflected the fleet-average optimization assumption for SCR controlled units that were not currently optimizing their controls. The optimized emission rate is multiplied by baseline heat input levels to arrive at the future year emissions estimate. The impact on future year emission assumptions is shown in column W and flagged in column X of the "unit 2021" through "unit 2025" worksheets. EPA notes this assumption only applies to ozone-season NOx as that is the season in which the Revised CSAPR Update Rule would likely incentivize such operation. In the final rule, EPA also incorporated a flag in column X, based on commenter input, for units with SCRs and a shared stack. For these units, based on commenter provided data, EPA did not assume potential emission reductions attributable to SCR optimization as explained in preamble section VI.B.

	2019	Future Year (e.g., 2021)
Unit x	10,000 MMBtu x .2 lb/MMBtu = 1 ton	10,000 MMBt*u* x *.08 lb/MMBtu* = *.4 ton*

b. *State-of-the- art combustion controls* – Emissions from units that were operating in 2019 without state-of-the-art combustion controls were adjusted downwards to reflect assumed

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[24] While less relevant to emission budgets setting, EPA also created a future year baseline for 1) NO_X and SO_2 emission from EGUs not currently covered under existing EPA programs that require emissions monitoring and reporting under 40 CFR part 75, and for other pollutants for all grid connected EGUs (e.g., $PM_{2.5}$, $P.M_{10}$, CO). These data points were used in some of the air quality analysis and in some of the system impacts estimates for the RIA. The EPA also evaluates whether the assumed aggregate heat input changes given retirements and new builds are consistent with trends observed historically in the fleet and with new planned units identified in EIA Form 860. This evaluation is in the appendix to this document.

installation of, or upgrade to, these controls and their expected emission rate impact. EPA assumed a future year emission rate of 0.199 for units expected to install/upgrade combustion controls. These emission rates were multiplied by each unit's future year baseline heat input to estimate its future emission level. Details of EPA's assessment of state-of-the-art NO_x combustion controls and corresponding emission rates are provided in the EGU NO_x Mitigation Strategies Final Rule TSD. The impact of state-of-the-art combustion controls on future year emission assumptions is shown in column Y and flagged in column Z of the "unit 2021" through "unit 2025" worksheets. EPA also incorporated a flag in column Z, based on commenter input, for units with a shared stack. For these units, based on commenter provided data, EPA did not assume potential emission reductions attributable to state-of-the-art combustion controls as explained in preamble section VI.B. Note, these assumptions apply to both winter and ozone season emissions adjustments as the controls operate continuously once installed.

	2019	Future Year (e.g., 2021)
Unit x	10,000 MMBtu x .4 lb/MMBtu = 2 ton	10,000 MMBt*u* x *.199lb/MMBtu* = ~1 *ton*

c. *SNCR optimization* - Emissions from units with existing SNCRs, but that operated at an emission rate greater than the SNCR optimization rate, were adjusted downwards to reflect expected emissions when the SNCR is optimized. This emission rate was identified specific to each unit based on historical data and is described in the EGU NOx Mitigation Strategy Final Rule TSD. The optimized emission rate is multiplied by future year baseline heat input levels to arrive at the future year emissions estimate. For the units affected by this adjustment, the impact on future year emission assumptions is shown in column AA and flagged in column AB of the "unit 2021" through "unit 2025" worksheets. Note, this assumption only applies to ozone-season NOx as that is the season in which the Revised CSAPR Update Rule would likely incentivize such installation and operation.

	2019	Future Year (e.g., 2021)
Unit x	10,000 MMBtu x .2 lb/MMBtu = 1 ton	10,000 MMBt*u* x *.15 lb/MMBtu* = .75 *ton*

d. *SNCR retrofit*– Emissions from coal units greater than 100 MW without post-combustion controls were adjusted downwards to reflect expected emissions if an SNCR were to be retrofitted on the unit. The emission rate was identified as 75% of the unit's baseline emission rate level (i.e., reflecting a 25% reduction from the technology). The adjusted emission rate is multiplied by future year baseline heat input levels to arrive at the future year emissions estimate for that technology. For the units affected by this adjustment, the impact on future year emission assumptions is shown in column AC and flagged in column AD of the "unit 2021" through "unit 2025" worksheets. Note, this assumption only applies to ozone-season NOx as that is the season in which the Revised CSAPR Update Rule would likely incentivize such installation and operation.

	2019	Future Year (e.g., 2021)
Unit x	10,000 MMBtu x .2 lb/MMBtu = 1 ton	10,000 MMBt*u* x *.15 lb/MMBtu* = .75 *ton*

e. SCR retrofit- Emissions from coal units greater than 100 MW without SCR controls were adjusted downwards to reflect expected emissions if an SCR were to be retrofitted on the unit. The emission rate was identified as 10% of the unit's baseline emission rate or 0.07 lb/MMBtu (i.e., a 90% reduction with an emission rate floor of 0.07 lb/MMBtu).[25] The adjusted emission rate is multiplied by future year baseline heat input levels to arrive at the future year emissions estimate for that technology. For the units affected by this adjustment, the impact on future year emission assumptions is shown in column AE and flagged in column AF of the "unit 2021" through "unit 2025" worksheets. Note, this assumption only applies to ozone-season NOx as that is the period in which the Revised CSAPR Update Rule would likely incentivize such installation and operation.

	2019	Future Year (e.g., 2021)
Unit x	10,000 MMBtu x .2 lb/MMBtu = 1 ton	10,000 MMBt*u* x *.07 lb/MMBtu* = .35 *ton*

These adjustments for each uniform control technology resulted in adjusted OS NOx emissions, heat input, and emission rates at the unit-level. When summed up to the state level, these changes resulted in the State OS NOx Emission Rate listed second in the formula below. EPA notes, this emission rate for any given uniform control level times the baseline heat input would provide the state emissions budget without generation shifting. These pre-generation shifting emission budget levels at the state-level are visible in the worksheets titled "State 2021" through "State 2025" in the *Appendix A: Final Rule State Emission Budget Calculations and Engineering Analytics* workbook accompanying this document.[26]

State 2021 OS NO$_X$ Budget =

$$\text{2021 State OS Baseline Heat Input} * [2021\ State\ OS\ NO_X\ Emissions\ Rate - (2021\ IPM\ Base\ Case\ OS\ NO_X\ Emissions\ Rate - \text{2021 IPM Cost Threshold } OS\ NO_X \text{ Emissions Rate})]$$

3. <u>Estimating Emission Reduction Potential from Generation Shifting</u>

The last two variables in the equation relate to emission reductions from generation shifting. Here, as in the CSAPR Update, EPA uses the Integrated Planning Model (IPM) to capture the change in emission rate in a state's fossil-fuel fired power fleet when. While holding everything else equal, EPA applies a given dollar per ton marginal cost constraint. EPA relies on IPM for this analysis as generation shifting occurs on a cost continuum and is a function of least-cost dispatch under different constraints. To derive this value, EPA first prepares an adjusted base case that reflects all the combustion or post-combustion mitigation measures discussed above for

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[25] This is a conservative estimate based on the floor rates for new SCRs in the IPM documentation, ranging from 0.05 to 0.07 lbs/mmBtu, depending on coal type. See "Documentation for EPA Base Case v.5.13 Using the Integrated Planning Model," table 5-5.

[26] EPA makes these illustrative unit-level details described in C.1 and C.2 available, before aggregating those values to use at the state and regional level. The illustrative unit-level values are meant to be a tool to inform a state-level estimate, not a prediction of how each unit will operate in the future. Although anchored in historical data, EPA recognizes at the unit-level some units will overperform and some units will underperform the unit-level illustrative values. It is an exercise in projecting reasonable state-level and region-level totals, not an exercise that purports to predict the future of millions of operational variables at the unit-level. This is discussed further in the Budgets section of the Response to Comment Document.

a given cost threshold. These adjusted base cases are specific to the uniform mitigation scenario. For instance, for the $1,600 per ton scenario EPA adjusts its base case to reflect the optimization of SCRs and combustion control upgrades by adjusting the emission rates to the levels discussed above for relevant units not already achieving that level. EPA then executes an IPM run with these new exogenous assumptions and observes the state-level emission rate for fossil-fuel fired units greater than 25 MW. This is the third variable in the emissions budget formula.

Next, EPA performs a sensitivity for these adjusted base case runs where it applies the same set of assumptions in variable three, but layers on a commensurate marginal cost price signal (e.g., $1,600 per ton). In addition to the mitigation measures assumed, the entire fossil-fuel fired EGU fleet greater than 25 MW in the state is subjected to a cost-per-ton price associated with that technology. The model solves for least-cost dispatch given this additional marginal cost constraints for seasonal ozone emissions. EPA observes the state-level emission rate for fossil-fuel fired units greater than 25 MW. This data point becomes the fourth variable in the state-emissions budget formula. The difference between the third and fourth variables reflects the change in emission rate due solely to generation shifting at a given dollar per ton level.

State 2021 OS NO$_X$ Budget =

$$\text{2021 State OS Baseline Heat Input} * [2021\ State\ OS\ NO_X\ Emissions\ Rate - \boxed{(2021\ IPM\ Base\ Case\ OS\ NO_X\ Emissions\ Rate - \text{2021 IPM Cost Threshold } OS\ NO_X\ \text{Emissions Rate})]}$$[27]

This difference in the state-level emission rate between the two IPM cases is shown in columns B through F in the worksheet titled “Generation Shifting”. These values are in the *Appendix A: Final Rule State Emission Budget Calculations and Engineering Analytics* workbook accompanying this document.

Once EPA calculated the change in emissions rate between the IPM adjusted base case and each cost threshold case, the EPA then subtracted this change in emissions rate from the state OS NOx emission rate without generation shifting (the second variable in the formula). This yielded state-level, historically-anchored, emission rates reflecting NO$_X$ reduction potential for a given uniform control measure.

Finally, the EPA multiplied these rates by each state’s adjusted heat input (historical heat input adjusted for retirements and new builds identified in variable one of the formula) to yield emission budgets for each cost threshold. The state budgets for the different cost thresholds are displayed in Table C-1 through C-5. EPA notes that budgets are calculated for all states for the purpose of AQAT analysis, as explained in section D of this TSD, even if the state is not covered by the Revised CSAPR Update Rule.

In addition to being shown below, the state-level emission budgets are calculated in the far right-hand side columns of each “State” worksheet for each mitigation technology scenario available that year. These budgets reflect an application of the formula described above to the data in the spreadsheet. These state-emission budgets reflect the inclusion of generation shifting.

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[27] The year in the formula changes for each year of budget calculation.

The difference between these final state-emission budgets shown in the far right columns that include “generation shifting” it the column title and the immediately preceding columns with the same column title but without “generation shifting” reflect the additional reduction due to generation shifting at a given cost threshold.

Generation shifting accounts for a small amount of emissions reductions relative to the combustion and post combustion control mitigation measures (see Table C-10). In its cost threshold modeling, EPA limited generation levels in a state to its base case level so that states would not achieve emission reductions by importing more generation from out-of-state EGUs and reducing in-state generation (e.g., emissions leakage). This assumption ensures that the generation shifting-based reductions are, and can be achieved, within a state. EPA also only assumes generation shifting from the projected baseline fleet, it does not incorporate generation shifting from any assumed incremental new build capacity that could be incentivized by a price level. Finally, in EPA’s budget setting process it only includes generation shifting at dollar per ton levels that encourage the optimization of existing or newly installed controls considered at that cost level. Capturing reduction potential from generation shifting in the state’s emission budgets is meant to preserve the incentive to implement EPA’s identified control strategy. Factoring generation shifting into the state emissions budgets helps promote an allowance price commensurate with these levels. In this rule, generation shifting is intended to be a mitigation measure supportive to those combustion and post-combustion control measures, not incremental to it. Therefore, EPA designed its IPM analysis and utilized the results for emission budget purposes in a manner that did not allow for, or include, emission reductions from projected model new builds or retirements that occurred in response to a dollar per ton price signal.[28] Instead, EPA examined generation shifting that was expected to occur among the baseline fleet at cost threshold levels commensurate with post-combustion control operation (e.g., $1,600 per ton) at fossil fuel-fired units greater than 25 MW for 2021.[29]

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[28] EPA also relied on the modeled emission rate change in the IPM 2021 results for each year of the budget calculation to avoid capturing generation shifting attributable to model-projected new builds in later years that are not yet under construction.

[29] As explained in preamble Section VI.B. and VI.C, EPA does not believe regional post-combustion control installation (represented by higher cost thresholds of $5,800/ton and $9,600/ton) is possible prior to 2025, and thus not relevant for consideration in this action as there are no nonattainment or maintenance receptors in 2025 after reductions available at $1,800/ton are implemented. However, for illustrative purposes, EPA assessed reductions at these levels as well. For the higher cost thresholds of $5,800/ton and $9,600/ton pertaining to the later years of analysis (2024 and 2025), EPA used the generation shifting emission rate delta consistent with the cost of operating any idled existing post-combustion control (e.g., $3,900/ton) to ensure that all controls (existing and new) would have an incentive to operate if installed. EPA also performed a feasibility check on its generation shifting assumptions to assess whether such generation shifting would still be likely once those assumed controls were installed. If the state’s assumed emission rate reductions from generation shifting were greater than 10% of the IPM baseline, and its adjusted historical baseline for that year was less than 90% of the IPM baseline, then no additional reductions were assumed from generation shifting at higher cost thresholds of $5,800 and $9,600 in EPA’s 2024 analysis. While this last assessment was done for all states, only Utah and Arizona (states which are not covered in this rulemaking) were affected.

Table C-1. 2021 Emissions for States at Different Uniform Control Scenarios (Reflected by dollar per ton)

	OS NOx (tons)				
	2021 Baseline	**$500/ton**	**0.08 SCR Optimization ($1,600/ton)**	**0.08 SCR Optimization + LNB ($1,600/ton)**	**0.08 SCR Optimization + LNB + SNCR Optimization ($1,800/ton)**
Alabama	7,786	7,785	7,786	7,693	7,693
Arizona	5,389	5,100	4,616	4,616	4,616
Arkansas	8,731	8,655	8,708	8,708	8,708
California	1,112	1,111	1,062	1,062	1,061
Colorado	7,484	7,487	7,471	7,471	7,449
Connecticut	344	316	307	307	307
Delaware	223	223	206	206	205
Florida	15,286	15,276	13,869	13,869	13,788
Fort Mojave	53	53	53	53	53
Georgia	7,833	7,833	7,808	7,808	7,808
Idaho	204	204	204	204	204
Illinois	9,368	9,348	9,198	9,198	9,102
Indiana	15,856	15,677	13,085	13,085	13,051
Iowa	8,567	8,447	7,714	7,659	7,659
Kansas	6,057	6,053	5,384	5,384	5,338
Kentucky	15,588	15,606	15,307	14,057	14,051
Louisiana	15,476	15,430	15,389	15,389	14,818
Maine	67	67	67	67	67
Maryland	1,501	1,501	1,499	1,499	1,499
Massachusetts	336	333	333	333	331
Michigan	13,898	13,126	12,732	12,614	12,610
Minnesota	5,969	5,842	5,448	5,448	5,448
Mississippi	8,070	8,067	8,065	7,739	7,739
Missouri	12,439	12,379	11,352	11,352	11,276
Montana	3,553	3,553	3,553	3,553	3,553
Navajo	1,319	1,319	1,319	1,319	1,319
Nebraska	8,078	8,013	8,037	7,530	7,530
Nevada	2,434	1,833	1,456	1,456	1,456
New Hampshire	386	386	299	299	299
New Jersey	1,346	1,346	1,253	1,253	1,253
New Mexico	4,656	4,624	4,502	4,502	4,488
New York	3,469	3,463	3,416	3,416	3,416
North Carolina	15,911	15,814	11,227	11,227	11,083
North Dakota	11,885	11,829	11,774	11,774	11,135
Ohio	15,829	15,487	9,690	9,690	9,690
Oklahoma	8,964	8,878	8,717	8,717	8,717
Oregon	350	350	350	350	350
Pennsylvania	11,896	11,807	8,379	8,379	8,379
Rhode Island	233	233	233	233	233
South Carolina	4,979	4,979	3,839	3,839	3,839
South Dakota	591	583	581	581	581
Tennessee	4,547	4,549	4,367	4,367	4,367
Texas	44,767	43,841	42,349	42,349	42,308
Utah	6,729	4,862	4,837	4,837	4,837
Ute	2,144	2,144	2,144	2,144	2,144
Vermont	51	51	51	51	51
Virginia	4,664	4,661	4,614	4,345	4,284
Washington	1,609	1,609	1,609	1,609	1,603

West Virginia	15,165	15,017	13,686	13,205	12,884
Wisconsin	5,251	5,120	4,952	4,952	4,945
Wyoming	11,480	11,480	11,366	10,623	10,623
12 Linked States Total	**124,057**	**122,469**	**108,248**	**106,130**	**105,037**

***Note – For 2021 EPA shows $1,600 ton with and without LNB upgrade; given it is not requiring budgets reflecting LNB controls until 2022.**

Table C-2. 2022 Emissions for States at Different Uniform Control Scenarios (Reflected by dollar per ton)

	OS NOx (tons)			
	2022 Baseline	**$500/ton**	**0.08 SCR Optimization + LNB ($1,600/ton)**	**0.08 SCR Optimization + LNB + SNCR Optimization ($1,800/ton)**
Alabama	7,786	7,785	7,693	7,693
Arizona	5,389	5,100	4,616	4,616
Arkansas	8,731	8,655	8,708	8,708
California	1,104	1,103	1,055	1,053
Colorado	7,484	7,487	7,471	7,449
Connecticut	341	313	304	304
Delaware	220	220	203	202
Florida	14,976	14,966	13,641	13,560
Fort Mojave	53	53	53	53
Georgia	7,833	7,833	7,808	7,808
Idaho	204	204	204	204
Illinois	9,368	9,348	9,198	9,102
Indiana	15,383	15,206	12,615	12,582
Iowa	8,567	8,447	7,659	7,659
Kansas	6,057	6,053	5,384	5,338
Kentucky	15,588	15,606	14,057	14,051
Louisiana	15,476	15,430	15,389	14,818
Maine	67	67	67	67
Maryland	1,267	1,267	1,266	1,266
Massachusetts	336	333	333	331
Michigan	13,459	12,688	12,295	12,290
Minnesota	5,888	5,761	5,369	5,369
Mississippi	8,070	8,067	7,739	7,739
Missouri	12,439	12,379	11,352	11,276
Montana	3,249	3,249	3,249	3,249
Navajo	1,319	1,319	1,319	1,319
Nebraska	8,078	8,013	7,530	7,530
Nevada	1,500	931	575	575
New Hampshire	386	386	299	299
New Jersey	1,346	1,346	1,253	1,253
New Mexico	4,656	4,624	4,502	4,488
New York	3,469	3,463	3,416	3,416
North Carolina	15,326	15,231	10,658	10,514
North Dakota	11,885	11,829	11,774	11,135
Ohio	15,927	15,569	9,773	9,773
Oklahoma	8,964	8,878	8,717	8,717
Oregon	350	350	350	350
Pennsylvania	11,896	11,806	8,373	8,373
Rhode Island	233	233	233	233
South Carolina	4,979	4,979	3,839	3,839
South Dakota	591	583	581	581

Tennessee	4,547	4,549	4,367	4,367
Texas	44,773	43,835	42,326	42,285
Utah	6,729	4,862	4,837	4,837
Ute	2,144	2,144	2,144	2,144
Vermont	51	51	51	51
Virginia	4,274	4,270	3,957	3,897
Washington	1,609	1,609	1,609	1,603
West Virginia	15,165	15,017	13,205	12,884
Wisconsin	4,992	4,864	4,700	4,693
Wyoming	10,918	10,918	10,061	10,061
12 Linked States Total	**122,619**	**121,016**	**104,797**	**103,705**

Table C-3. 2023 Emissions for States at Different Uniform Control Scenarios (Reflected by dollar per ton).

	OS NOx (tons)			
	2023 Baseline	**$500/ton**	**0.08 SCR Optimization + LNB ($1,600/ton)**	**0.08 SCR Optimization + LNB + SNCR Optimization ($1,800/ton)**
Alabama	7,786	7,785	7,693	7,693
Arizona	5,389	5,100	4,616	4,616
Arkansas	8,731	8,655	8,708	8,708
California	1,104	1,103	1,055	1,053
Colorado	6,663	6,666	6,650	6,629
Connecticut	341	313	304	304
Delaware	220	220	203	202
Florida	14,496	14,486	13,162	13,080
Fort Mojave	53	53	53	53
Georgia	7,154	7,154	7,129	7,129
Idaho	204	204	204	204
Illinois	8,413	8,393	8,275	8,179
Indiana	15,357	15,179	12,587	12,553
Iowa	7,647	7,531	6,753	6,753
Kansas	6,057	6,053	5,384	5,338
Kentucky	15,588	15,606	14,057	14,051
Louisiana	15,476	15,430	15,389	14,818
Maine	67	67	67	67
Maryland	1,267	1,267	1,266	1,266
Massachusetts	320	317	317	315
Michigan	11,182	10,386	9,980	9,975
Minnesota	4,655	4,545	4,198	4,198
Mississippi	8,070	8,067	7,739	7,739
Missouri	12,160	12,101	11,074	10,997
Montana	3,249	3,249	3,249	3,249
Navajo	1,319	1,319	1,319	1,319
Nebraska	8,078	8,013	7,530	7,530
Nevada	1,386	828	479	479
New Hampshire	386	386	299	299
New Jersey	1,346	1,346	1,253	1,253
New Mexico	1,693	1,673	1,594	1,594
New York	3,474	3,468	3,421	3,421
North Carolina	15,326	15,231	10,658	10,514
North Dakota	9,166	9,128	9,091	8,452

Ohio	15,927	15,569	9,773	9,773
Oklahoma	8,964	8,878	8,717	8,717
Oregon	350	350	350	350
Pennsylvania	11,896	11,806	8,373	8,373
Rhode Island	233	233	233	233
South Carolina	4,979	4,979	3,839	3,839
South Dakota	591	583	581	581
Tennessee	4,547	4,549	4,367	4,367
Texas	44,582	43,646	42,138	42,097
Utah	6,729	4,862	4,837	4,837
Ute	2,144	2,144	2,144	2,144
Vermont	51	51	51	51
Virginia	4,361	4,357	4,041	3,980
Washington	1,609	1,609	1,609	1,603
West Virginia	15,165	15,017	13,205	12,884
Wisconsin	4,857	4,734	4,576	4,569
Wyoming	10,337	10,337	9,480	9,480
12 Linked States Total	**119,453**	**117,824**	**101,620**	**100,526**

Table C-4. 2024 Emissions for States at Different Uniform Control Scenarios (Reflected by dollar per ton).

	OS NOx (tons)					
	2024 Baseline	**$500/ton**	**0.08 SCR Optimization + LNB ($1,600/ton)**	**0.08 SCR Optimization + LNB + SNCR Optimization ($1,800/ton)**	**0.08 SCR Optimization + LNB + SNCR Optimization + SNCR Retrofit ($5,800/ton)**	**0.08 SCR Optimization + LNB + SNCR Optimization + SCR Retrofit ($9,600/ton)**
Alabama	7,786	7,785	7,693	7,693	7,694	7,515
Arizona	5,389	5,100	4,616	4,616	4,816	3,916
Arkansas	8,731	8,655	8,708	8,708	6,642	4,661
California	1,104	1,103	1,055	1,053	1,053	1,053
Colorado	5,950	5,953	5,938	5,916	5,085	3,826
Connecticut	341	313	304	304	302	302
Delaware	220	220	203	202	194	194
Florida	14,505	14,495	13,170	13,089	12,446	11,752
Fort Mojave	53	53	53	53	53	53
Georgia	7,154	7,154	7,129	7,129	7,097	7,097
Idaho	204	204	204	204	204	204
Illinois	8,292	8,272	8,154	8,059	7,239	6,891
Indiana	12,232	12,083	9,585	9,564	8,923	8,430
Iowa	7,647	7,531	6,753	6,753	5,201	2,817
Kansas	6,057	6,053	5,384	5,338	4,815	3,658
Kentucky	15,588	15,606	14,057	14,051	12,322	9,775
Louisiana	15,476	15,430	15,389	14,818	14,378	12,622
Maine	67	67	67	67	67	67
Maryland	1,350	1,350	1,348	1,348	1,168	1,168
Massachusetts	320	317	317	315	307	307
Michigan	10,968	10,188	9,791	9,786	8,670	7,344
Minnesota	4,655	4,545	4,198	4,198	3,034	2,581
Mississippi	8,070	8,067	7,739	7,739	7,081	6,436
Missouri	12,160	12,101	11,074	10,997	10,744	9,301
Montana	3,249	3,249	3,249	3,249	2,445	1,544
Navajo	1,319	1,319	1,319	1,319	1,319	1,319
Nebraska	7,347	7,283	7,299	7,299	5,966	4,246

Nevada	1,386	828	479	479	332	100
New Hampshire	386	386	299	299	299	299
New Jersey	1,346	1,346	1,253	1,253	1,257	1,257
New Mexico	1,693	1,673	1,594	1,594	1,187	1,187
New York	3,456	3,450	3,403	3,403	3,297	3,297
North Carolina	15,326	15,231	10,658	10,514	7,981	4,691
North Dakota	9,166	9,128	9,091	8,452	7,237	2,250
Ohio	15,927	15,569	9,773	9,773	9,644	9,222
Oklahoma	8,964	8,878	8,717	8,717	7,820	7,251
Oregon	350	350	350	350	350	350
Pennsylvania	11,896	11,806	8,373	8,373	7,921	7,851
Rhode Island	233	233	233	233	233	233
South Carolina	4,903	4,903	3,769	3,769	3,762	3,762
South Dakota	591	583	581	581	583	583
Tennessee	4,547	4,549	4,367	4,367	4,280	4,280
Texas	43,265	42,338	40,845	40,804	35,342	29,460
Utah	6,729	4,862	4,837	4,837	5,094	3,174
Ute	2,144	2,144	2,144	2,144	1,608	573
Vermont	51	51	51	51	51	51
Virginia	4,025	4,021	3,707	3,663	3,618	3,184
Washington	1,609	1,609	1,609	1,603	1,603	761
West Virginia	15,165	15,017	13,205	12,884	12,837	10,568
Wisconsin	4,161	4,043	3,893	3,886	3,862	3,862
Wyoming	10,337	10,337	9,480	9,480	6,997	3,972
12 Linked States Total	**115,722**	**114,138**	**98,038**	**96,975**	**91,274**	**81,609**

Table C-5. 2025 Emissions for States at Different Uniform Control Scenarios (Reflected by dollar per ton).

	OS NOx (tons)					
	2025 Baseline	$500/ton	0.08 SCR Optimization + LNB ($1,600/ton)	0.08 SCR Optimization + LNB + SNCR Optimization ($1,800/ton)	0.08 SCR Optimization + LNB + SNCR Optimization + SNCR Retrofit ($5,800/ton)	0.08 SCR Optimization + LNB + SNCR Optimization + SCR Retrofit ($9,600/ton)
Alabama	7,786	7,785	7,693	7,693	7,694	7,515
Arizona	5,389	5,100	4,616	4,616	4,816	3,916
Arkansas	8,731	8,655	8,708	8,708	6,642	4,661
California	1,104	1,103	1,055	1,053	1,053	1,053
Colorado	5,950	5,953	5,938	5,916	5,085	3,826
Connecticut	341	313	304	304	302	302
Delaware	220	220	203	202	194	194
Florida	13,938	13,929	12,604	12,523	11,882	11,188
Fort Mojave	53	53	53	53	53	53
Georgia	7,154	7,154	7,129	7,129	7,097	7,097
Idaho	204	204	204	204	204	204
Illinois	8,281	8,261	8,143	8,047	7,228	6,880
Indiana	12,232	12,083	9,585	9,564	8,923	8,430
Iowa	7,647	7,531	6,753	6,753	5,201	2,817
Kansas	6,057	6,053	5,384	5,338	4,815	3,658
Kentucky	14,551	14,567	13,352	13,345	11,796	9,529
Louisiana	15,476	15,430	15,389	14,818	14,378	12,622
Maine	67	67	67	67	67	67
Maryland	1,350	1,350	1,348	1,348	1,168	1,168
Massachusetts	320	317	317	315	307	307
Michigan	11,009	10,211	9,804	9,800	8,678	7,352

Minnesota	4,655	4,545	4,198	4,198	3,034	2,581
Mississippi	8,070	8,067	7,739	7,739	7,081	6,436
Missouri	12,147	12,088	11,061	10,985	10,732	9,288
Montana	3,249	3,249	3,249	3,249	2,445	1,544
Navajo	1,319	1,319	1,319	1,319	1,319	1,319
Nebraska	7,347	7,283	7,299	7,299	5,966	4,246
Nevada	1,386	828	479	479	332	100
New Hampshire	386	386	299	299	299	299
New Jersey	1,346	1,346	1,253	1,253	1,257	1,257
New Mexico	1,693	1,673	1,594	1,594	1,187	1,187
New York	3,456	3,450	3,403	3,403	3,297	3,297
North Carolina	14,281	14,188	9,632	9,538	7,055	4,483
North Dakota	9,166	9,128	9,091	8,452	7,237	2,250
Ohio	15,927	15,569	9,773	9,773	9,644	9,222
Oklahoma	8,964	8,878	8,717	8,717	7,820	7,251
Oregon	350	350	350	350	350	350
Pennsylvania	11,896	11,806	8,373	8,373	7,921	7,851
Rhode Island	233	233	233	233	233	233
South Carolina	4,903	4,903	3,769	3,769	3,762	3,762
South Dakota	591	583	581	581	583	583
Tennessee	3,953	3,954	3,907	3,907	3,826	3,826
Texas	43,125	42,199	40,708	40,667	35,207	29,325
Utah	6,729	4,862	4,837	4,837	5,094	3,174
Ute	2,144	2,144	2,144	2,144	1,608	573
Vermont	51	51	51	51	51	51
Virginia	4,162	4,158	3,839	3,795	3,745	3,312
Washington	1,609	1,609	1,609	1,603	1,603	761
West Virginia	15,165	15,017	13,205	12,884	12,837	10,568
Wisconsin	3,769	3,660	3,519	3,512	3,490	3,490
Wyoming	10,337	10,337	9,480	9,480	6,997	3,972
12 Linked States Total	**114,850**	**113,248**	**97,467**	**96,403**	**90,872**	**81,488**

As noted in Section VI of the Preamble, EPA identified $1,800 per ton as the point for determining significant contribution from EGUs under the Step 3 multifactor test. Section VII explains that EPA applied this cost threshold to each year through 2024 to arrive at a budget estimate for that year. Those state-level emissions budgets for the 12 states along with the corresponding percent reduction relative to 2019 and the state's baseline emissions for that year are shown below in Tables C-6 through C-10.[30]

Table C-6 - OS NOx, 2021 Emissions Budget, and % Reduction

	2016 OS NOx	2019 OS NOx	Baseline 2021 OS NOx	2021 Budget	% Reduction from 2019	% Reduction from 2021 Baseline
Illinois	14,553	11,877	9,368	9,102	23%	3%
Indiana	34,636	16,594	15,856	13,051	21%	18%
Kentucky	25,403	19,117	15,588	15,300	20%	2%
Louisiana	19,615	15,365	15,476	14,818	4%	4%
Maryland	4,471	1,662	1,501	1,499	10%	0%

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[30] A table providing state emission budgets and associated variability limits for these 12 linked states is provided in Appendix G

Michigan	17,632	14,055	13,898	12,727	9%	8%
New Jersey	2,463	1,346	1,346	1,253	7%	7%
New York	6,534	3,225	3,469	3,416	-6%	2%
Ohio	24,205	16,390	15,829	9,690	41%	39%
Pennsylvania	31,896	12,093	11,896	8,379	31%	30%
Virginia	9,833	4,668	4,664	4,516	3%	3%
West Virginia	21,178	15,615	15,165	13,334	15%	12%
Total	**212,418**	**132,006**	**124,057**	**107,085**	**19%**	**13.7%**

Table C-7. OS NOx, 2022 Emissions Budget, and % Reduction

	2016 OS NOx	2019 OS NOx	Baseline 2022 OS NOx	2022 Budget	% Reduction from 2019	% Reduction from 2022 Baseline
Illinois	14,553	11,877	9,368	9,102	23%	3%
Indiana	34,636	16,594	15,383	12,582	24%	18%
Kentucky	25,403	19,117	15,588	14,051	27%	10%
Louisiana	19,615	15,365	15,476	14,818	4%	4%
Maryland	4,471	1,662	1,267	1,266	24%	0%
Michigan	17,632	14,055	13,459	12,290	13%	9%
New Jersey	2,463	1,346	1,346	1,253	7%	7%
New York	6,534	3,225	3,469	3,416	-6%	2%
Ohio	24,205	16,390	15,927	9,773	40%	39%
Pennsylvania	31,896	12,093	11,896	8,373	31%	30%
Virginia	9,833	4,668	4,274	3,897	17%	9%
West Virginia	21,178	15,615	15,165	12,884	17%	15%
Total	**212,418**	**132,006**	**122,619**	**103,705**	**21%**	**15.4%**

Table C-8. OS NOx, 2023 Emissions Budget, and % Reduction

	2016 OS NOx	2019 OS NOx	Baseline 2023 OS NOx	2023 Budget	% Reduction from 2019	% Reduction from 2023 Baseline
Illinois	14,553	11,877	8,413	8,179	31%	3%
Indiana	34,636	16,594	15,357	12,553	24%	18%
Kentucky	25,403	19,117	15,588	14,051	27%	10%
Louisiana	19,615	15,365	15,476	14,818	4%	4%
Maryland	4,471	1,662	1,267	1,266	24%	0%
Michigan	17,632	14,055	11,182	9,975	29%	11%
New Jersey	2,463	1,346	1,346	1,253	7%	7%
New York	6,534	3,225	3,474	3,421	-6%	2%
Ohio	24,205	16,390	15,927	9,773	40%	39%
Pennsylvania	31,896	12,093	11,896	8,373	31%	30%

Virginia	9,833	4,668	4,361	3,980	15%	9%
West Virginia	21,178	15,615	15,165	12,884	17%	15%
Total	**212,418**	**132,006**	**119,453**	**100,526**	**24%**	**15.8%**

Table C-9. OS NOx, 2024 Onward: Emissions Budget, and % Reduction

	2016 OS NOx	2019 OS NOx	Baseline 2024 OS NOx	2024 Budget	% Reduction from 2019	% Reduction from 2024 Baseline
Illinois	14,553	11,877	8,292	8,059	32%	3%
Indiana	34,636	16,594	12,232	9,564	42%	22%
Kentucky	25,403	19,117	15,588	14,051	27%	10%
Louisiana	19,615	15,365	15,476	14,818	4%	4%
Maryland	4,471	1,662	1,350	1,348	19%	0%
Michigan	17,632	14,055	10,968	9,786	30%	11%
New Jersey	2,463	1,346	1,346	1,253	7%	7%
New York	6,534	3,225	3,456	3,403	-6%	2%
Ohio	24,205	16,390	15,927	9,773	40%	39%
Pennsylvania	31,896	12,093	11,896	8,373	31%	30%
Virginia	9,833	4,668	4,025	3,663	22%	9%
West Virginia	21,178	15,615	15,165	12,884	17%	15%
Total	**212,418**	**132,006**	**115,722**	**96,975**	**27%**	**16.2%**

Table C-10. Emission Reduction Attributable to Generation Shifting (for 12 linked states).

	Baseline OS NOx	Budget Without Gen Shifting	Budget With Gen. Shifting	% Reduction from Generation Shifting as a Percentage of Baseline
2021	124,057	109,578	107,085	2%
2022	122,619	106,211	103,705	2%
2023	119,453	103,077	100,526	2%
2024	115,722	99,446	96,975	2%

4. <u>Variability Limits and RIA Scenarios</u>

Once EPA determined state-emission budgets, EPA calculated the variability limits and assurance levels for each state based on the calculated emission budgets. Each state's variability limit is 21% of its budget, and its assurance level is the sum of its budget and variability limit (or 121% of its budget). The variability limits and assurance levels are further described and shown in section VII of the preamble for the Revised CSAPR Update and shown in Table Appendix G-1.

As explained in the preamble, the EPA is finalizing EGU NO$_X$ ozone season emission budgets reflecting the uniform cost threshold of $1,800 per ton to eliminate significant contribution to nonattainment and interference with maintenance.

For the RIA analysis, EPA used the budgets informed by the $1,800 per ton cost threshold scenario. Additionally, the RIA includes analysis of the less stringent policy option, using the budgets from a $500 per ton cost threshold case, and a more stringent policy alternative, using 2025 budgets from the $9,600 per ton cost threshold case reflecting SCR retrofits at coal units greater than 100 MW lacking such controls.

The IPM runs performed for this analysis are listed in Appendix C of this TSD. Table Appendix C-1 lists the name of each IPM run next to a description of the run. The output files of these model runs can be found in the rulemaking docket. Detailed budget calculations for all cost per ton cases can be found in *Appendix A – Final Rule State Emission Budget Calculations and Engineering Analytics*.

D. Analysis of Air Quality Responses to Emission Changes Using an Ozone Air Quality Assessment Tool (AQAT)

EPA has defined each linked upwind state's significant contribution to nonattainment and interference with maintenance of downwind air quality using a multi-factor test (described in the preamble at section VI in step three of the 4-Step Good Neighbor Framework) which is based on cost, emissions, and air quality factors. A key quantitative input for determining the amount of each state's emission reduction obligation is the predicted downwind ambient air quality impacts of upwind EGU emission reductions under the budgets at various levels of NO_X emission control and under a scenario of potential upwind non-EGU emissions reductions. See section C of this TSD for information regarding EGUs and see preamble section VI for information about non-EGUs. The emission reductions from the various cost thresholds can potentially result in air quality improvements such that individual receptors drop below the level of the NAAQS based on the cumulative air quality improvement from the upwind states, or potentially decrease each upwind state's contributions such that they possibly drop below the 1% linkage threshold (used in step two of the Good Neighbor Framework to identify the states for further analysis).

Air quality modeling would be the optimal way to examine these questions at each cost threshold level from EGUs and non-EGUs. However, due to time and resource limitations EPA was unable to use photochemical air quality modeling for all but a few emissions scenarios. Therefore, in order to estimate the air quality impacts for the various levels of emission reductions and to ensure that each step of its analysis is informed by the evolving emissions data, EPA used a simplified air quality assessment tool (AQAT).[31] The simplified tool allows the Agency to analyze many more NO_X emission budget levels than would otherwise be possible. EPA recognizes that AQAT is not the equivalent of photochemical air quality modeling. However, AQAT is directly informed by air quality modeling data. Further, AQAT has evolved through iterative development under the original CSAPR and the CSAPR Update. One such evolution is its calibration of the change in air quality based on air quality modeling of a particular emission reduction scenario. As done at proposal, EPA examined various cost threshold scenarios for the year 2024 using two different calibration factors as a mechanism to estimate the range of results.

The inputs and outputs of the tool can be found in the "Ozone_AQAT_Final.xlsx" excel workbook.

The remainder of section D of this document will:

- Present an introduction and overview of the ozone AQAT;
- Describe the construction of the ozone AQAT; and
- Provide the results of the NO_X emission cost threshold analyses.

1. Introduction: Development of the ozone AQAT

The ozone AQAT was developed for use in the rule's step three air quality analysis as part of the multi-factor test. Specifically, the AQAT was designed to evaluate air quality

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[31] EPA used CAMx to model several base cases (i.e., one of 2016, one of 2023, and one of 2028). The EPA calculated air quality contributions for each state for both the 2023 and 2028 cases. EPA did not explicitly model 2021.

changes in response to emissions changes in order to quantify necessary emission reductions under the good neighbor provision and to evaluate potential budgets for over-control as to either the 1% threshold or the downwind receptor status. EPA described and used a similar tool in the original CSAPR to evaluate good neighbor obligations with respect to the fine particulate matter ($PM_{2.5}$) NAAQS and in the CSAPR Update to evaluate good neighbor obligations with respect to ozone. For the CSAPR Update, EPA refined both the construction and application of the assessment tool for use in estimating changes in ozone concentrations in response to changes in NO_X emissions. We followed the methodology developed in the CSAPR Update rulemaking where we calibrate the response of a pollutant using two CAMx simulations at different emission levels.[32,33] The construction of the AQAT for the final rule is essentially the same as that for the proposed rule.

A critical factor in the assessment tool is the establishment of a relationship between ozone season NO_X emission reductions and reductions in ozone. Within AQAT, on a receptor-by-receptor basis, we assume that the reduction of a ton of emissions of NO_X from the upwind state results in a particular level of improvement in air quality downwind.[34] For the purposes of developing and using an assessment tool to compare the air quality impacts of NO_X emission reductions under various emission cost threshold emission levels, we determine the relationship between changes in emissions and changes in ozone contributions on a receptor-by-receptor basis. Specifically, EPA assumed that, within the range of total NO_X emissions being considered (as defined by the cost threshold emission levels or changes from year-to-year), a change in ozone season NO_X emissions leads to a proportional change in downwind ozone contributions.[35] This proportional relationship was then modified using calibration factors created using the 2023 base case contribution air quality modeling and either the 2016 base case (for cases between 2016 and 2023) or the 2028 base case (for cases from 2023 to 2028) to account for the majority of the nonlinearity between emissions and ozone concentrations. For example, for a particular receptor in 2022, we could assume that a 20% decrease in the upwind state's emissions leads to a

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[32] In CSAPR, we estimated changes in sulfate using changes in SO_2 emissions.

[33] In this rule, as was the case for the CSAPR Update, we used CAMx to calibrate the assessment tool's predicted change in ozone concentrations to changes in NO_X emissions. This calibration is receptor-specific and is based on the changes in NO_X emissions and resulting ozone concentrations between the 2023 base case and either the 2016 base case or the 2028 base case. One of these two calibration points (either 2016 or 2028) was used to create site-specific calibration factors so that the response of ozone concentrations to upwind NO_X emission changes would more closely align with ozone estimates from CAMx. For time periods before 2023, we used the 2016 calibration point, for 2023 and later, we used the 2028 calibration point.

[34] This downwind air quality improvement is assumed to be indifferent to the source sector or the location of the particular emission source within the state where the ton was reduced. For example, reducing one ton of NO_X emissions from the power sector is assumed to have the same downwind ozone reduction as reducing one ton of NO_X emissions from the mobile source sector.

[35] The relationship between NO_X emissions and ozone concentrations is known to be non-linear when examined over large ranges of NO_X emissions (e.g., J.H. Seinfeld and S.N. Pandis, Atmospheric Chemistry and Physics From Air Pollution to Climate Change, 2nd Edition, John Wiley and Sons, 2006, Hoboken, NJ, pp 236-237). However, for smaller ranges of NO_X and VOC emissions, while meteorological conditions are held constant, the relationship may be reasonably linear. The nonlinearities are evident over tens of ppb of ozone changes with tens of percent changes in the overall emission inventories. For most states examined here, under the various control scenarios, most changes in the emission inventory are on the order of a few percent and most air quality changes are on the order of a fraction of a ppb. In this assessment tool, we are assuming a linear relationship between NO_X emissions and ozone concentrations calibrated between two CAMx simulations. A significant portion of the nonlinearity is accounted for by using the calibration factor and having the air quality estimates occur at levels of emissions between the 2023 base case and the other base case used in the calibration (which were both modeled in CAMx).

20% decrease in its downwind ozone contribution in the "uncalibrated" ozone AQAT, while following the application of the calibration factor (based on the change to 2016) it may only decrease by 10% in "calibrated" AQAT (where the calibration factor is 0.5). Typically, the calibration factors were substantially less than one, often on the order of 0.3 (thus, a 10% decrease in emissions would result in a 3% decrease in ozone concentration). The creation of the calibration factors is described in detail in section D.2.c (1) of this TSD.

In summary, because the tool is only being used over a range for which a calibration factor has been developed, and because other options such as using CAMx to model all scenarios is cost and time-prohibitive, EPA used ozone AQAT to estimate the downwind ozone reductions due to upwind NO_X emission reductions for the air quality input to the multi-factor test for this rule. Other options, such as directly scaling the results (i.e., an "uncalibrated ozone AQAT") will likely greatly overestimate the air quality impacts of emission reductions.[36]

Section D.2, below, is a technical explanation of the construction of the ozone AQAT. Readers who prefer to access the results of the analysis using the ozone AQAT are directed to section D.3.

2. Details on the construction of the ozone AQAT

(a) Overview of the ozone AQAT

This section describes the step-by-step development process for the ozone AQAT. All the input and output data can be found in the Excel worksheets described in Appendix B. In the ozone AQAT, EPA links state-by-state NO_X emission reductions (derived from the photochemical model, the non-EGU assessment and/or the IPM EGU modeling combined with the EGU engineering assessment) with 2023 CAMx modeled ozone contributions in order to predict ozone concentrations at different levels of emission levels at monitoring sites. The reduction in ozone contributions for each year at each cost threshold level and the resulting air quality improvement at monitoring sites with projected nonattainment and/or maintenance problems were then considered in a multi-factor test for identifying the level of emissions reductions that define significant contribution to nonattainment and interference with maintenance.

In applying AQAT to analyze air quality improvements at a given receptor for the cost threshold scenarios, emissions were reduced in only those upwind states that were "linked" to that receptor in step 2 of the Good Neighbor Framework (i.e., those states that contributed an air quality impact at or above 1 percent of the NAAQS). Emissions were also reduced in the state that contained that receptor (regardless of the level of that state's contribution) at a level of control stringency consistent with the budget level applied in upwind states.

Specifically, the key estimates from the ozone AQAT for each receptor are:

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[36] Directly scaling the results is the equivalent of using a second calibration point with an assumption that zero emissions results in zero contribution. While clearly this is a reasonable assumption for that emission level, using this in the calibration process assumes that the emission and air quality relationship is linear throughout the entire ozone regime (e.g., from 0 ppb all the way up to 80 ppb or so). Clearly, there is important non-linearity over this range.

- The ozone contribution as a function of emissions at each cost threshold level, for each upwind state that is contributing above the 1 percent air quality threshold and the state containing the receptor.
- The ozone contribution under base case NO_X emissions in the various years, for each upwind state that is not above the 1 percent air quality threshold for that receptor.
- The non-anthropogenic (i.e., background, boundary, biogenic, and wildfire) ozone concentrations. These are assumed to be constant and equal to the contributions from the 2023 base case source apportionment modeling.

The results of the ozone AQAT analysis for each emission cost threshold level for EGUs and non-EGUs can be found in section D.3 of this document.

(b) Data used to construct the ozone AQAT for this rule

Several air quality modeling and emissions inventory sources were used to construct the calibrated ozone AQAT for this rule. Using the calibration factors, EPA modulated the 2023 CAMx ozone season contributions for each upwind state to each downwind receptor. These modulations were enough to adjust the concentrations to represent a different year (e.g., 2021). In all cases, the starting point was the 2023 base case CAMx run with contributions. For each scenario, EPA multiplied each state's percent change in emissions relative to the 2023 base case ozone season NO_X emission inventories from all source sectors used in the source apportionment CAMx air quality modeling (this includes all anthropogenic sources and excludes biogenic sources and wildfires) by the receptor-specific calibration factor and the state's base case contribution. Note that the 2023 scenario in CAMx used IPM emission estimates while the 2016 base case used EGU continuous emissions monitoring system (CEMS) data. The base case emission inventories for the 2023 base case and the 2016 and 2028 base cases are discussed in the Air Quality Modeling TSD. An additional emission inventory (i.e., for 2021) was also developed. The EGU emissions for this inventory were replaced with emission estimates used throughout Step 3. This emission inventory is described in the Emission Inventory TSD. The ozone season NO_X EGU and non-EGU emissions for each emission scenario including the base case as modeled in AQAT are described in section C of this TSD.

As described in the Air Quality Modeling TSD, the air quality contributions and emissions were modeled for all states in the contiguous United States and the District of Columbia. Thus, in the ozone AQAT, any emission differences between the 2023 air quality modeling base case and the scenario would result in changes in air quality contributions and ozone concentrations at the downwind monitors.

(c) Detailed outline of the process for constructing and utilizing the ozone AQAT

The ozone AQAT was created and used in a multi-step process. First, a calibrated ozone AQAT was created using the contributions and emission inventory from the 2023 base case air quality modeling as well as the 2016 base case (for all scenarios with years greater than or equal to 2023, the calibrated AQAT used the design values and emission inventory from the 2028 base case). The construction of this was identical to that from the proposal. For each emissions cost threshold scenario evaluated, for each state, EPA identified the percent change in anthropogenic

NO_X emissions relative to the 2023 base case and multiplied this by the receptor-specific calibration factor as well as by the state- and receptor-specific contribution. This resulted in a state- and receptor-specific "change in contribution" relative to the 2023 base case. Each state's change in contribution value was then added to (or subtracted from) its 2023 base case contribution and the results summed for all states for each receptor. To this total of each state's contribution to each receptor, the receptor-specific base case contributions from the other source-categories were added (modified if necessary in the same way if necessary to adjust to a different year), resulting in an estimated design value for each receptor.[37] The calibrated ozone AQAT was used to project the ozone concentrations for each NO_X emission budget level on a receptor-by-receptor basis for every monitor throughout the domain.

In order to facilitate understanding of the calibration process, EPA describes below a demonstrative example: monitor number 090019003 in Fairfield County, Connecticut, with a 2023 base case projected ozone average design value of 76.9 parts per billion (ppb) and maximum design value of 77.2 ppb.

(1) Create the calibration factors

The process for creating the calibration factors remains unchanged from the method used in the CSAPR Update. This section repeats the process and data from the proposal. To create the calibration factors, EPA used emissions, contributions, and design values from the 2023 CAMx run that used IPM for emissions, and the emissions and design values from either the 2016 or 2028 CAMx base cases. All changes in emissions and air quality are relative to the proposed 2023 CAMx base case.

First, EPA used ozone season state-level 2023 base case total NO_X emissions from all source sectors. This emissions data is divided into multiple source sectors for the purposes of air quality modeling: airports, beis, cmv_c1c2_12, cmv_c3_12, nonpt, nonroad, np_oilgas, onroad, pt_oilgas, ptagfire, ptegu, ptfire, ptnonipm, rail, rwc (see the Preparation of Emissions Inventories for 2016v1 North American Emissions Modeling Platform TSD for additional details on the emissions inventories used in the CAMx air quality modeling). The anthropogenic state-level total NO_X emissions used in the air quality contribution modeling are the sum of emissions from all these source sectors except (beis, ptagfire, and ptfire). Next, EPA summed the ozone season total anthropogenic NO_X emissions across all relevant source sectors for both the 2016 and 2028 base cases. EPA calculated the ratio of the emissions for each of these two base cases to the total emissions for the 2023 base case for each state modeled in CAMx. More information on the emissions inventories can be found in the preamble to the proposed rule. The total emissions data and resulting ratios can be found in Table D-1 and in the ozone AQAT worksheet "calib_emiss".

For each monitor, the "uncalibrated" change in concentration was found by multiplying each state's 2023 base case ozone air quality contribution by the difference in the state's ratio of emissions. The difference in the ratio of emissions was calculated as the difference in total ozone season anthropogenic NO_X emissions between the either the 2016 base case (or the 2028 base case) and the 2023 base case scenario divided by the 2023 base case emission. Thus, when the 2016 or 2028 base case had smaller emissions than the 2023 base case, the net result was a negative number. Each state's fractional change in emissions was multiplied by its 2023 base

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[37] Details on procedures for calculating average and maximum design values can be found in the Air Quality Modeling TSD.

case contribution to get a state- specific change in contribution (Table D-1). For each monitor, the change in concentrations was summed across all states. The result was the total “uncalibrated” change in concentration.

Table D-1. The 2023, 2016, and 2028 Base Cases Total Anthropogenic NO$_X$ Emissions with 2023 Ozone Contributions (ppb) and Uncalibrated Contributions for 2016 and 2023 for the Westport Monitor Number 090019003 in Fairfield County, Connecticut.

State	2023 Base Case NO$_X$ Emissions	2016 Base Case NO$_X$ Emissions	2028 Base Case NO$_X$ Emissions	Fraction of 2016 Base Case Emissions to 2023 Base Case Emissions	Fraction of 2028 Base Case Emissions to 2023 Base Case Emissions	2023 Base Case Ozone Contributions	Uncalibrated Change in AQ Contribution for 2016	Uncalibrated Change in AQ Contribution for 2028	Uncalibrated Contribution 2016	Uncalibrated Contribution 2028
AL	67,839	101,168	60,574	0.491	-0.107	0.113	0.056	-0.012	0.169	0.101
AZ	45,043	70,225	37,041	0.559	-0.178	0.016	0.009	-0.003	0.025	0.013
AR	46,552	68,756	40,093	0.477	-0.139	0.176	0.084	-0.024	0.259	0.151
CA	145,157	212,134	133,619	0.461	-0.079	0.035	0.016	-0.003	0.051	0.032
CO	61,473	86,684	55,852	0.410	-0.091	0.065	0.027	-0.006	0.091	0.059
CT	12,724	18,874	11,227	0.483	-0.118	2.682	1.296	-0.316	3.979	2.367
DE	6,985	10,193	6,274	0.459	-0.102	0.425	0.195	-0.043	0.620	0.382
DC	1,610	2,338	1,348	0.453	-0.163	0.041	0.019	-0.007	0.060	0.035
FL	114,045	186,866	99,721	0.639	-0.126	0.075	0.048	-0.009	0.123	0.065
GA	73,702	115,451	65,044	0.566	-0.117	0.165	0.093	-0.019	0.258	0.146
ID	19,924	29,416	16,389	0.476	-0.177	0.028	0.013	-0.005	0.041	0.023
IL	103,625	143,831	93,027	0.388	-0.102	0.798	0.310	-0.082	1.107	0.716
IN	82,323	129,702	73,428	0.576	-0.108	1.239	0.713	-0.134	1.952	1.105
IA	48,818	67,053	41,876	0.374	-0.142	0.169	0.063	-0.024	0.232	0.145
KS	69,568	91,022	61,361	0.308	-0.118	0.129	0.040	-0.015	0.168	0.114
KY	51,946	88,409	45,953	0.702	-0.115	0.854	0.599	-0.098	1.453	0.755
LA	105,245	138,804	98,692	0.319	-0.062	0.266	0.085	-0.017	0.351	0.250
ME	13,132	19,133	11,619	0.457	-0.115	0.007	0.003	-0.001	0.010	0.006
MD	27,785	43,974	24,694	0.583	-0.111	1.181	0.688	-0.131	1.869	1.050
MA	33,006	45,621	29,957	0.382	-0.092	0.079	0.030	-0.007	0.110	0.072
MI	87,686	118,418	81,141	0.350	-0.075	1.678	0.588	-0.125	2.266	1.553
MN	63,293	89,970	53,343	0.421	-0.157	0.188	0.079	-0.030	0.267	0.159
MS	33,963	56,364	30,491	0.660	-0.102	0.101	0.067	-0.010	0.168	0.091
MO	74,595	116,616	63,863	0.563	-0.144	0.356	0.200	-0.051	0.556	0.305
MT	28,901	40,605	24,884	0.405	-0.139	0.075	0.030	-0.010	0.105	0.064
NE	43,475	59,121	37,771	0.360	-0.131	0.076	0.028	-0.010	0.104	0.066
NV	19,070	30,601	15,844	0.605	-0.169	0.012	0.007	-0.002	0.020	0.010
NH	7,763	11,753	6,806	0.514	-0.123	0.018	0.009	-0.002	0.028	0.016
NJ	37,738	58,456	33,624	0.549	-0.109	8.446	4.637	-0.921	13.083	7.525
NM	53,165	70,102	47,356	0.319	-0.109	0.038	0.012	-0.004	0.051	0.034
NY	77,766	106,248	69,004	0.366	-0.113	14.141	5.179	-1.593	19.320	12.547
NC	76,448	101,378	64,646	0.326	-0.154	0.548	0.179	-0.085	0.727	0.464
ND	46,471	58,914	41,774	0.268	-0.101	0.080	0.021	-0.008	0.101	0.071
OH	98,579	141,543	87,637	0.436	-0.111	2.506	1.092	-0.278	3.598	2.228
OK	101,105	120,286	92,941	0.190	-0.081	0.195	0.037	-0.016	0.233	0.180
OR	31,443	46,235	26,228	0.470	-0.166	0.028	0.013	-0.005	0.041	0.023
PA	112,449	160,648	100,275	0.429	-0.108	6.723	2.882	-0.728	9.604	5.995
RI	4,742	6,994	4,106	0.475	-0.134	0.010	0.005	-0.001	0.015	0.009
SC	46,385	67,218	40,781	0.449	-0.121	0.177	0.079	-0.021	0.256	0.155
SD	13,753	21,784	10,688	0.584	-0.223	0.047	0.028	-0.011	0.075	0.037
TN	57,191	89,762	50,022	0.569	-0.125	0.318	0.181	-0.040	0.499	0.278
TX	314,342	418,972	288,147	0.333	-0.083	0.582	0.194	-0.049	0.776	0.534
UT	35,868	53,661	31,932	0.496	-0.110	0.033	0.016	-0.004	0.049	0.029
VT	4,047	6,078	3,340	0.502	-0.175	0.014	0.007	-0.002	0.021	0.011
VA	57,856	93,453	51,398	0.615	-0.112	1.273	0.783	-0.142	2.057	1.131
WA	58,962	89,605	49,093	0.520	-0.167	0.055	0.028	-0.009	0.083	0.046
WV	53,854	61,692	52,047	0.146	-0.034	1.459	0.212	-0.049	1.671	1.410
WI	48,283	75,140	41,731	0.556	-0.136	0.229	0.127	-0.031	0.357	0.198
WY	41,098	53,908	36,966	0.312	-0.101	0.078	0.024	-0.008	0.103	0.070
TRIBAL	5,858	17,759	5,875	2.032	0.003	0.004	0.009	0.000	0.013	0.004
CAN_MEX				0	0	2.52895	0	0	2.52895	2.52895
OFFSHORE				0	0	0.67413	0	0	0.67413	0.67413
FIRE				0	0	0.34482	0	0	0.34482	0.34482
ICBC				0	0	20.63261	0	0	20.63261	20.63261
BIOG				0	0	4.68736	0	0	4.68736	4.68736

Next, the estimate of the monitor specific ozone responses under the 2016 or 2028 base cases was used to calibrate the ozone AQAT to CAMx and to derive the calibration factors. One factor was created using the 2016 base and is applied to all scenarios from 2016 through 2022, the other factor was created using the 2028 base and is applied to all scenarios from 2023 to 2028. First, the changes in ozone predicted by the ozone AQAT and CAMx for the average design values were calculated for each monitor for the 2016 or 2028 base case relative to the 2023 base case concentrations. The change in ozone predicted by CAMx was then divided by the change in ozone predicted by the uncalibrated AQAT, resulting in a monitor-specific calibration factor (see Table D-2 for an example calculation using the 2016 and 2028 base cases). The calculation of these monitor-specific calibration factors provided EPA with the ability to align the ozone response predicted by the ozone AQAT to the ozone response predicted by CAMx.

The ozone AQAT and CAMx concentration differences can be found in the "Ozone AQAT_Final.xlsx" excel workbook in columns BK and BL, respectively, on worksheets "calib_2016" and "calib_2028". The resulting calibration factors can be found in column BM of the aforementioned excel worksheets. The calibration factor, multiplied by the fractional change in emissions (relative to the 2023) base and multiplied by the 2023 base air quality contribution, results in the fractional change in air quality contribution for any alternative scenario.

Table D-2. Design Values in the 2023 Base Case and the 2016 and 2028 Base Cases and Estimated Change in Design Value Relative to the 2023 Base Case from CAMx and Uncalibrated AQAT for the Westport Monitor Number 090019003 in Fairfield County, Connecticut.

	2023 Base Case Concentration (ppb)	**2016 Base Case Concentration (ppb)**	**2028 Base Case Concentration (ppb)**	**Change in Concentration from 2016 to 2023 (ppb)**	**Change in Concentration from 2028 to 2023 (ppb)**
CAMx	76.90	82.70	74.30	5.80	-2.60
Uncalibrated AQAT	76.90	98.04	71.70	21.14	-5.20
Calibration Factor – Change in Concentration from CAMx Divided by Change in Concentration from the Uncalibrated AQAT				0.2743	0.4998

<u>(2) Create a calibrated version of the ozone AQAT for emission budget analysis for the proposed rule</u>

Next, as was done at proposal, EPA used 2023 base case emissions and 2023 base case air quality ozone contributions from the air quality modeling along with either the 2016-based or 2028-based calibration factors to create a "calibrated" AQAT specific to the year being assessed.

EPA examined the changes in the 2023 air quality contributions from changes in emissions relative to the 2023 base case emissions (while using the calibration factor). This calibrated AQAT was then used to estimate the change in predicted ozone due to NO_X emission reductions under each emission cost threshold level evaluated for EGUs and non-EGUs in each year.

First, as described in section VI of the preamble and above in section C of this TSD for EGUs, EPA identified various cost threshold levels of emissions based on projected changes in emissions rates and adjusted historical data. For each state, for each year, the total anthropogenic NOx emissions (excluding the EGU emissions) are presented in Table D-3. These "straight line" emissions inventories were created by linearly interpolating the emissions for all anthropogenic source sectors except EGUs between 2023 and 2016 (or between 2023 and 2028). An additional set of sensitivity analyses were done for 2021 and 2022 using the 2021 emission inventory directly and by linearly interpolating the emissions for all source sectors (except EGUs) between the 2021 and 2023 inventories.

The EGU point inventory is composed of emissions from units that report emissions to EPA's Clean Air Markets Division (CAMD) under 40 CFR Part 75 (most emissions from these sources are measured by CEMS) and units that are typically included in EPA's power sector modeling using the Integrated Planning Model (IPM) but that do not report to CAMD and typically lack CEMS (i.e., the nonCEM units). Within the air quality modeling platform, different approaches are taken depending on whether an emissions inventory for EGUs is created using an IPM-based emission estimates or an engineering analysis based platform. The nonCEM components for various air quality model platforms are shown in Table D-4. For each year, based on the available air quality modeling runs available (in 2016, 2023, and 2028) an engineering-based nonCEM point EGU component was created (Table D-5). For the years from 2016 through 2023, this was a straight line linear interpolation of the 2016 and 2023 nonCEM component from the engineering based air quality runs. For years 2023 through 2028, we used 2023 nonCEM values held constant for all years. The component of the EGU point inventory from CAMD reporting units (labelled "CEMs") was developed using engineering analysis (see section C for details). For each year, we show EGU emissions for units with CEMs as a function of cost threshold level (see Tables C-1 through C-5 for the years 2021 through 2025, respectively). These levels include:

- Engineering Baseline,
- \$500/ton,
- Optimize SCR,
- Optimize SCR + State-of-the-Art Combustion Controls (referred to as Low NOx Burners, or LNB),
- Optimize SNCR+ SCR ,
- Optimize SNCR+ SCR + LNB ,
- New SNCR + Optimize SNCR+ SCR + LNB
- New SCR + Optimize SNCR+ SCR + LNB.

In the construction of AQAT, for each scenario, we assembled an emission inventory from all anthropogenic sources for each state. In other words, we combine the year-specific anthropogenic emissions from Table D-3, with the relevant EGU nonCEM component from D-5, and one of the EGU CEM estimates from Tables C-1 through C-5.

Finally, these emission totals are compared to the 2023 case that was modeled with CAMx. For each emission cost threshold level in each analysis year, EPA calculated the ratio of the emission differences from the scenario and the 2023 air quality modeling base case to the total NO_X emissions for the 2023 air quality modeling base case used in the air quality modeling for each state (see Tables D-6 through D-10). Scenarios that are not viable, for technical or policy reasons, have been grayed out in these tables.

For each year, we also created a complete "straight line" emissions inventory including a linear interpolation of the EGU inventory from the air quality modeling between 2023 and 2016 and between 2023 and 2028. For the sensitivity analysis, the interpolation was between 2021 and 2023. The emission differences and air quality estimates for the two sensitivity scenarios can be found in Appendix H. In Table D-11, we examined the emission reduction for non-EGUs in tranche 1 for glass and cement controls below $2,000 per ton, and then estimated the ratio of the emission difference relative to the 2023 air quality modeling base case.

For each cost threshold level analyzed, on a receptor-by-receptor basis, the emissions change for each upwind state is associated with one of two emission levels (either the engineering base case emission level for that year or the particular cost threshold level) depending on whether the upwind state is "linked" to that receptor or if the receptor is located within the state. States that are contributing above the air quality threshold (i.e., greater than or equal to 1 percent of the NAAQS) to the monitor, as well as the state containing the monitor, make NO_X emission reductions available at the particular cost threshold level for that year. The emissions for all other states are adjusted to the engineering base case level for that year.

For the $1,800/ton control case at various years, all states that were linked to any receptor in 2021 were simultaneously adjusted to the emission levels in the control case, regardless of whether (or not) the state was "linked" to a particular receptor. This scenario examines the emission results when budgets have been applied to the geography. For each monitor, the predicted change in contribution of ozone from each state is calculated by multiplying the state-specific 2023 base case ozone contributions from the air quality modeling by the calibration factor as well as by the ratio of the change in emissions (Tables D-1 and D-6 through D-10, for either the emission cost threshold level or the engineering base case emission level depending on whether the state is linked).[38] This calibrated change in ozone is then added to the ozone contribution from the 2023 base case air quality modeling. The result is the state and receptor specific "calibrated" total ozone contribution after implementation of the emission at a particular cost threshold level.

For each monitor, these state-level "calibrated" contributions are then summed to estimate total ozone contribution from the states to a particular receptor in the CAMx modeling domain. Finally, "other" modeled ozone contributions ("CAN_MEX", "OFFSHORE", "USCANMEX_FIRE", "ICBC", and "BIOG") are added from the 2023 base case air quality modeling to the state contributions to account for other sources of ozone affecting the modeling domain. The total ozone from all the states and "other" contributions equals the average design values estimated in the assessment tool. The maximum design values were estimated by multiplying the estimated average design values by the ratio of the modeled 2023 base case maximum to average design values.

Generally, as the emission cost threshold stringency increased, the estimated average and maximum design values at each receptor decreased. In the assessment tool, the estimated value of the average design value was used to estimate whether the location will be out of attainment,

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[38] The change in concentration can be positive or negative, depending on whether the state's total anthropogenic ozone season NOx emissions for the scenario are larger or smaller than the 2023 air quality modeling base case emission level.

while the estimated maximum design value was used to estimate whether the location will have problems maintaining the NAAQS. The area was noted as having a nonattainment or maintenance issue if either estimated air quality level was greater than or equal to 76 ppb.

Table D-3. Ozone Season Anthropogenic NOX Emissions (Tons) without EGUs for Each State.

State	2021	2022	2023	2024	2025	2026	2021 Sensitivity	2022 Sensitivity
Alabama	69,987	66,163	62,338	60,603	58,868	57,134	66,126	64,232
Arizona	45,793	42,719	39,644	38,220	36,796	35,371	42,094	40,869
Arkansas	42,259	39,586	36,914	35,793	34,672	33,551	40,275	38,594
California	161,697	152,246	142,795	140,823	138,852	136,880	155,951	149,373
Colorado	59,562	56,774	53,986	52,934	51,881	50,829	55,717	54,852
Connecticut	12,579	11,683	10,787	10,496	10,205	9,914	11,598	11,193
Delaware	7,443	7,053	6,664	6,514	6,365	6,216	7,046	6,855
District of Columbia	1,817	1,713	1,609	1,556	1,504	1,452	1,678	1,643
Florida	113,717	105,687	97,657	94,900	92,143	89,385	101,801	99,729
Georgia	77,170	71,638	66,107	64,178	62,248	60,319	71,469	68,788
Idaho	22,332	21,039	19,745	19,039	18,333	17,627	21,057	20,401
Illinois	103,427	98,260	93,094	90,938	88,782	86,626	97,378	95,236
Indiana	73,016	68,763	64,511	62,670	60,829	58,988	69,443	66,977
Iowa	42,556	39,903	37,250	35,915	34,580	33,246	40,668	38,959
Kansas	67,361	64,151	60,941	59,345	57,749	56,153	64,927	62,934
Kentucky	49,241	46,459	43,676	42,486	41,296	40,106	46,190	44,933
Louisiana	101,112	98,267	95,423	94,142	92,862	91,582	99,116	97,269
Maine	13,285	12,535	11,786	11,486	11,186	10,886	12,544	12,165
Maryland	28,862	26,913	24,963	24,334	23,705	23,076	25,561	25,262
Massachusetts	33,806	32,138	30,469	29,869	29,269	28,669	31,101	30,785
Michigan	81,760	77,760	73,761	72,229	70,696	69,163	77,274	75,518
Minnesota	62,574	58,958	55,342	53,789	52,236	50,683	61,433	58,387
Mississippi	35,723	33,389	31,055	30,299	29,543	28,787	33,414	32,234
Missouri	68,437	63,937	59,436	57,302	55,169	53,035	64,699	62,068
Montana	27,412	26,140	24,868	24,079	23,290	22,501	27,238	26,053
Nebraska	38,582	36,322	34,063	32,847	31,631	30,414	37,204	35,634
Nevada	21,229	19,836	18,443	17,822	17,202	16,581	19,156	18,799
New Hampshire	8,429	7,948	7,466	7,280	7,093	6,906	7,803	7,634
New Jersey	41,044	38,117	35,189	34,314	33,439	32,564	37,016	36,102
New Mexico	52,452	50,678	48,905	47,794	46,684	45,573	51,454	50,179
New York	78,610	74,563	70,517	68,874	67,231	65,587	71,570	71,043
North Carolina	68,043	63,994	59,944	58,207	56,469	54,732	63,635	61,790
North Dakota	37,522	36,370	35,218	34,332	33,446	32,561	38,415	36,816
Ohio	90,701	85,504	80,307	78,080	75,853	73,626	86,304	83,306
Oklahoma	96,329	94,061	91,794	89,825	87,856	85,887	95,756	93,775
Oregon	34,601	32,676	30,751	29,716	28,681	27,646	32,399	31,575
Pennsylvania	106,545	102,733	98,920	96,913	94,906	92,899	98,613	98,767
Rhode Island	5,095	4,739	4,384	4,258	4,133	4,007	4,661	4,522
South Carolina	45,792	42,877	39,963	38,799	37,636	36,472	42,507	41,235
South Dakota	15,556	14,414	13,273	12,653	12,032	11,412	14,992	14,132
Tennessee	61,367	57,590	53,813	52,363	50,913	49,462	56,856	55,335
Texas	297,010	283,927	270,845	265,662	260,480	255,297	287,305	279,075
Utah	33,095	31,333	29,572	28,803	28,034	27,266	30,909	30,240
Vermont	4,583	4,311	4,038	3,897	3,756	3,614	4,332	4,185
Virginia	61,278	57,313	53,347	51,893	50,439	48,985	55,980	54,664
Washington	65,990	62,147	58,305	56,338	54,371	52,404	62,042	60,173
West Virginia	37,555	37,047	36,540	36,056	35,573	35,089	37,819	37,179
Wisconsin	50,430	47,071	43,713	42,447	41,182	39,917	47,763	45,738
Wyoming	34,845	34,165	33,486	33,011	32,536	32,061	34,546	34,016
Tribal Data	2,742	2,743	2,744	2,754	2,764	2,773	2,723	2,734

Table D-4. EGU Point Source NO_X Emissions (Tons) from Units without CEMs from AQ Modeling Inventory.

State	2016 Eng EGU nonCEMs	2023 IPM EGU nonCEMs	2023 Eng EGU nonCEMs	2028 IPM EGU nonCEMs
Alabama	482	473	200	450
Arizona	367	1,012	377	1,117
Arkansas	141	526	87	528
California	1,972	1,674	1,968	444
Colorado	334	604	277	998
Connecticut	1,272	1,759	1,362	1,788
Delaware	80	131	80	142
District of Columbia	0	0	0	0
Florida	6,189	8,376	6,466	8,569
Georgia	1,580	838	1,640	856
Idaho	528	164	413	161
Illinois	55	1,070	49	1,128
Indiana	611	1,165	722	1,115
Iowa	635	797	618	880
Kansas	109	1,001	93	653
Kentucky	1	366	1	561
Louisiana	3,885	1,943	3,908	1,964
Maine	1,972	1,280	1,908	1,275
Maryland	901	1,930	924	1,983
Massachusetts	2,363	2,044	2,349	2,046
Michigan	1,367	3,825	1,367	3,939
Minnesota	1,740	1,556	1,502	1,522
Mississippi	1,726	959	1,341	952
Missouri	471	331	456	349
Montana	933	3	933	3
Nebraska	665	750	664	748
Nevada	155	268	155	253
New Hampshire	374	215	374	206
New Jersey	1,083	1,844	1,022	1,955
New Mexico	98	72	98	88
New York	1,996	5,068	2,094	5,142
North Carolina	740	1,559	862	1,827
North Dakota	156	116	14	121
Ohio	722	1,881	981	1,961
Oklahoma	1	753	277	695
Oregon	712	515	712	515
Pennsylvania	2,187	5,945	2,543	5,573
Rhode Island	35	313	35	308
South Carolina	604	647	698	834
South Dakota	30	23	30	24
Tennessee	7	510	116	508
Texas	1,996	5,101	2,026	4,623
Utah	561	109	48	91
Vermont	61	9	0	9
Virginia	2,995	2,772	2,996	2,962
Washington	1,536	565	1,503	550
West Virginia	1	0	1	0
Wisconsin	61	612	92	617
Wyoming	11	0	0	0
Tribal Data	50	455	71	3,080

Table D-5. EGU Point Source NO_X Emissions (Tons) from Units without CEMs Adjusted by Year.

State	2021	2022	2023	2024	2025	2026	2021 Sensitivity	2022 Sensitivity
Alabama	280	240	200	200	200	200	280	240
Arizona	374	376	377	377	377	377	374	376
Arkansas	102	95	87	87	87	87	102	95
California	1,969	1,969	1,968	1,968	1,968	1,968	1,969	1,969
Colorado	294	286	277	277	277	277	294	286
Connecticut	1,337	1,349	1,362	1,362	1,362	1,362	1,337	1,349
Delaware	80	80	80	80	80	80	80	80
District of Columbia	0	0	0	0	0	0	0	0
Florida	6,387	6,426	6,466	6,466	6,466	6,466	6,387	6,426
Georgia	1,623	1,631	1,640	1,640	1,640	1,640	1,623	1,631
Idaho	446	429	413	413	413	413	446	429
Illinois	50	50	49	49	49	49	50	50
Indiana	690	706	722	722	722	722	690	706
Iowa	623	621	618	618	618	618	623	621
Kansas	98	95	93	93	93	93	98	95
Kentucky	1	1	1	1	1	1	1	1
Louisiana	3,902	3,905	3,908	3,908	3,908	3,908	3,902	3,905
Maine	1,926	1,917	1,908	1,908	1,908	1,908	1,926	1,917
Maryland	918	921	924	924	924	924	918	921
Massachusetts	2,353	2,351	2,349	2,349	2,349	2,349	2,353	2,351
Michigan	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367
Minnesota	1,570	1,536	1,502	1,502	1,502	1,502	1,570	1,536
Mississippi	1,451	1,396	1,341	1,341	1,341	1,341	1,451	1,396
Missouri	460	458	456	456	456	456	460	458
Montana	933	933	933	933	933	933	933	933
Nebraska	664	664	664	664	664	664	664	664
Nevada	155	155	155	155	155	155	155	155
New Hampshire	374	374	374	374	374	374	374	374
New Jersey	1,039	1,031	1,022	1,022	1,022	1,022	1,039	1,031
New Mexico	98	98	98	98	98	98	98	98
New York	2,066	2,080	2,094	2,094	2,094	2,094	2,066	2,080
North Carolina	827	845	862	862	862	862	827	845
North Dakota	54	34	14	14	14	14	54	34
Ohio	907	944	981	981	981	981	907	944
Oklahoma	198	237	277	277	277	277	198	237
Oregon	712	712	712	712	712	712	712	712
Pennsylvania	2,441	2,492	2,543	2,543	2,543	2,543	2,441	2,492
Rhode Island	35	35	35	35	35	35	35	35
South Carolina	671	684	698	698	698	698	671	684
South Dakota	30	30	30	30	30	30	30	30
Tennessee	85	100	116	116	116	116	85	100
Texas	2,017	2,021	2,026	2,026	2,026	2,026	2,017	2,021
Utah	195	122	48	48	48	48	195	122
Vermont	18	9	0	0	0	0	18	9
Virginia	2,996	2,996	2,996	2,996	2,996	2,996	2,996	2,996
Washington	1,513	1,508	1,503	1,503	1,503	1,503	1,513	1,508
West Virginia	1	1	1	1	1	1	1	1
Wisconsin	83	88	92	92	92	92	83	88
Wyoming	3	2	0	0	0	0	3	2
Tribal Data	65	68	71	71	71	71	65	68

Table D-6. 2021 Fractional Difference in Emissions Relative to 2023 Air Quality Modeling Base Case for Each State.

State	Eng Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR+ SCR	Optimize SNCR+ SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB	Straight Line Interpolation
Alabama	0.151	0.151	0.151	0.149	0.151	0.149	0.149	0.147	0.140
Arizona	0.145	0.138	0.127	0.127	0.127	0.127	0.132	0.112	0.160
Arkansas	0.098	0.096	0.097	0.097	0.097	0.097	0.053	0.010	0.136
California	0.135	0.135	0.135	0.135	0.135	0.135	0.135	0.135	0.132
Colorado	0.095	0.095	0.095	0.095	0.095	0.095	0.077	0.046	0.117
Connecticut	0.121	0.119	0.118	0.118	0.118	0.118	0.118	0.118	0.138
Delaware	0.109	0.109	0.107	0.107	0.106	0.106	0.105	0.105	0.131
District of Columbia	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129
Florida	0.187	0.187	0.175	0.175	0.174	0.174	0.168	0.162	0.182
Georgia	0.175	0.175	0.175	0.175	0.175	0.175	0.175	0.175	0.162
Idaho	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.136
Illinois	0.089	0.089	0.087	0.087	0.086	0.086	0.078	0.075	0.111
Indiana	0.088	0.086	0.054	0.054	0.054	0.054	0.040	0.024	0.164
Iowa	0.060	0.058	0.043	0.041	0.043	0.041	0.009	-0.040	0.107
Kansas	0.057	0.057	0.047	0.047	0.046	0.046	0.039	0.022	0.088
Kentucky	0.248	0.248	0.243	0.219	0.242	0.218	0.185	0.136	0.201
Louisiana	0.145	0.144	0.144	0.144	0.139	0.139	0.134	0.118	0.091
Maine	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.131
Maryland	0.126	0.126	0.126	0.126	0.126	0.126	0.120	0.117	0.166
Massachusetts	0.106	0.106	0.106	0.106	0.106	0.106	0.105	0.105	0.109
Michigan	0.107	0.098	0.093	0.092	0.093	0.092	0.079	0.064	0.100
Minnesota	0.108	0.106	0.100	0.100	0.100	0.100	0.080	0.072	0.120
Mississippi	0.332	0.332	0.332	0.322	0.332	0.322	0.303	0.284	0.188
Missouri	0.090	0.090	0.076	0.076	0.075	0.075	0.071	0.052	0.161
Montana	0.104	0.104	0.104	0.104	0.104	0.104	0.076	0.045	0.116
Nebraska	0.089	0.087	0.088	0.076	0.088	0.076	0.044	0.003	0.103
Nevada	0.249	0.217	0.198	0.198	0.198	0.198	0.178	0.138	0.173
New Hampshire	0.184	0.184	0.173	0.173	0.173	0.173	0.173	0.173	0.147
New Jersey	0.151	0.151	0.148	0.148	0.148	0.148	0.148	0.148	0.157
New Mexico	0.076	0.075	0.073	0.073	0.073	0.073	0.061	0.024	0.091
New York	0.082	0.082	0.081	0.081	0.081	0.081	0.080	0.080	0.105
North Carolina	0.109	0.108	0.048	0.048	0.046	0.046	0.012	-0.031	0.093
North Dakota	0.064	0.063	0.062	0.062	0.048	0.048	0.006	-0.112	0.077
Ohio	0.090	0.086	0.028	0.028	0.028	0.028	0.026	0.022	0.125
Oklahoma	0.043	0.043	0.041	0.041	0.041	0.041	0.032	0.026	0.054
Oregon	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
Pennsylvania	0.075	0.074	0.044	0.044	0.044	0.044	0.040	0.039	0.122
Rhode Island	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.136
South Carolina	0.109	0.109	0.084	0.084	0.084	0.084	0.084	0.084	0.128
South Dakota	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.167
Tennessee	0.154	0.154	0.151	0.151	0.151	0.151	0.149	0.149	0.163
Texas	0.094	0.091	0.086	0.086	0.086	0.086	0.067	0.047	0.095
Utah	0.116	0.064	0.063	0.063	0.063	0.063	0.070	0.017	0.142
Vermont	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.143
Virginia	0.192	0.191	0.191	0.186	0.189	0.185	0.184	0.177	0.176
Washington	0.172	0.172	0.172	0.172	0.172	0.172	0.172	0.158	0.148
West Virginia	-0.021	-0.024	-0.049	-0.057	-0.055	-0.063	-0.064	-0.106	0.042
Wisconsin	0.155	0.152	0.149	0.149	0.149	0.149	0.148	0.146	0.159
Wyoming	0.127	0.127	0.124	0.106	0.124	0.106	0.046	-0.028	0.089
Tribal Data	0.079	0.079	0.079	0.079	0.079	0.079	-0.012	-0.189	0.580

Note: Scenarios that are not viable, for technical or policy reasons, have been grayed out

Table D-7. 2022 Fractional Difference in Emissions Relative to 2023 Air Quality Modeling Base Case for Each State.

State	Eng Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR+ SCR	Optimize SNCR+ SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB	Straight Line Interpolation
Alabama	0.094	0.094	0.094	0.092	0.094	0.092	0.092	0.090	0.070
Arizona	0.076	0.070	0.059	0.059	0.059	0.059	0.064	0.044	0.080
Arkansas	0.040	0.038	0.039	0.039	0.039	0.039	-0.005	-0.047	0.068
California	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.066
Colorado	0.050	0.050	0.050	0.050	0.049	0.049	0.032	0.000	0.059
Connecticut	0.051	0.049	0.048	0.048	0.048	0.048	0.048	0.048	0.069
Delaware	0.053	0.053	0.050	0.050	0.050	0.050	0.049	0.049	0.066
District of Columbia	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.065
Florida	0.114	0.114	0.103	0.103	0.102	0.102	0.096	0.090	0.091
Georgia	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.081
Idaho	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.068
Illinois	0.039	0.039	0.037	0.037	0.037	0.037	0.029	0.025	0.055
Indiana	0.031	0.029	-0.003	-0.003	-0.003	-0.003	-0.015	-0.029	0.082
Iowa	0.006	0.003	-0.012	-0.013	-0.012	-0.013	-0.045	-0.094	0.053
Kansas	0.011	0.011	0.001	0.001	0.000	0.000	-0.007	-0.024	0.044
Kentucky	0.194	0.195	0.189	0.165	0.189	0.165	0.132	0.083	0.100
Louisiana	0.118	0.117	0.117	0.117	0.112	0.112	0.107	0.091	0.046
Maine	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.065
Maryland	0.047	0.047	0.047	0.047	0.047	0.047	0.042	0.042	0.083
Massachusetts	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
Michigan	0.056	0.047	0.043	0.043	0.043	0.043	0.030	0.015	0.050
Minnesota	0.049	0.047	0.041	0.041	0.041	0.041	0.021	0.014	0.060
Mississippi	0.262	0.262	0.262	0.252	0.262	0.252	0.233	0.214	0.094
Missouri	0.030	0.029	0.015	0.015	0.014	0.014	0.011	-0.008	0.080
Montana	0.049	0.049	0.049	0.049	0.049	0.049	0.021	-0.010	0.058
Nebraska	0.037	0.035	0.036	0.024	0.036	0.024	-0.007	-0.049	0.051
Nevada	0.127	0.097	0.078	0.078	0.078	0.078	0.071	0.059	0.086
New Hampshire	0.122	0.122	0.111	0.111	0.111	0.111	0.111	0.111	0.073
New Jersey	0.073	0.073	0.071	0.071	0.071	0.071	0.071	0.071	0.078
New Mexico	0.043	0.042	0.040	0.040	0.039	0.039	0.028	-0.010	0.046
New York	0.030	0.030	0.029	0.029	0.029	0.029	0.028	0.028	0.052
North Carolina	0.049	0.047	-0.012	-0.012	-0.014	-0.014	-0.047	-0.091	0.047
North Dakota	0.039	0.038	0.037	0.037	0.023	0.023	-0.019	-0.137	0.038
Ohio	0.039	0.035	-0.024	-0.024	-0.024	-0.024	-0.025	-0.030	0.062
Oklahoma	0.021	0.020	0.019	0.019	0.019	0.019	0.010	0.004	0.027
Oregon	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.067
Pennsylvania	0.042	0.041	0.010	0.010	0.010	0.010	0.006	0.006	0.061
Rhode Island	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.068
South Carolina	0.046	0.046	0.022	0.022	0.022	0.022	0.022	0.022	0.064
South Dakota	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.083
Tennessee	0.088	0.088	0.085	0.085	0.085	0.085	0.084	0.084	0.081
Texas	0.052	0.049	0.044	0.044	0.044	0.044	0.026	0.005	0.048
Utah	0.065	0.013	0.012	0.012	0.012	0.012	0.019	-0.035	0.071
Vermont	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.072
Virginia	0.116	0.116	0.115	0.111	0.114	0.110	0.109	0.101	0.088
Washington	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.093	0.074
West Virginia	-0.030	-0.033	-0.058	-0.067	-0.064	-0.073	-0.074	-0.116	0.021
Wisconsin	0.080	0.077	0.074	0.074	0.074	0.074	0.073	0.073	0.079
Wyoming	0.097	0.097	0.094	0.076	0.094	0.076	0.016	-0.058	0.045
Tribal Data	0.080	0.080	0.080	0.080	0.080	0.080	-0.011	-0.188	0.290

Table D-8. 2023 Fractional Difference in Emissions Relative to 2023 Air Quality Modeling Base Case for Each State.

State	Eng Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR+ SCR	Optimize SNCR+ SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB	Straight Line Interpolation
Alabama	0.037	0.037	0.037	0.035	0.037	0.035	0.035	0.033	0.000
Arizona	0.008	0.002	-0.009	-0.009	-0.009	-0.009	-0.005	-0.025	0.000
Arkansas	-0.018	-0.019	-0.018	-0.018	-0.018	-0.018	-0.062	-0.105	0.000
California	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.000
Colorado	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.026	-0.055	0.000
Connecticut	-0.018	-0.021	-0.021	-0.021	-0.021	-0.021	-0.021	-0.021	0.000
Delaware	-0.003	-0.003	-0.005	-0.005	-0.006	-0.006	-0.007	-0.007	0.000
District of Columbia	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.000
Florida	0.040	0.040	0.028	0.028	0.028	0.028	0.022	0.016	0.000
Georgia	0.016	0.016	0.016	0.016	0.016	0.016	0.015	0.015	0.000
Idaho	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.000
Illinois	-0.020	-0.020	-0.021	-0.021	-0.022	-0.022	-0.030	-0.034	0.000
Indiana	-0.021	-0.023	-0.055	-0.055	-0.055	-0.055	-0.067	-0.080	0.000
Iowa	-0.068	-0.070	-0.085	-0.086	-0.085	-0.086	-0.118	-0.167	0.000
Kansas	-0.036	-0.036	-0.045	-0.045	-0.046	-0.046	-0.053	-0.070	0.000
Kentucky	0.141	0.141	0.135	0.111	0.135	0.111	0.078	0.029	0.000
Louisiana	0.091	0.090	0.090	0.090	0.085	0.085	0.080	0.064	0.000
Maine	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.000
Maryland	-0.023	-0.023	-0.023	-0.023	-0.023	-0.023	-0.028	-0.028	0.000
Massachusetts	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.000
Michigan	-0.016	-0.025	-0.029	-0.029	-0.029	-0.029	-0.042	-0.057	0.000
Minnesota	-0.028	-0.030	-0.036	-0.036	-0.036	-0.036	-0.054	-0.061	0.000
Mississippi	0.191	0.191	0.191	0.182	0.191	0.182	0.162	0.143	0.000
Missouri	-0.034	-0.035	-0.049	-0.049	-0.050	-0.050	-0.053	-0.072	0.000
Montana	0.005	0.005	0.005	0.005	0.005	0.005	-0.023	-0.054	0.000
Nebraska	-0.015	-0.017	-0.016	-0.028	-0.016	-0.028	-0.059	-0.101	0.000
Nevada	0.048	0.019	0.000	0.000	0.000	0.000	-0.007	-0.019	0.000
New Hampshire	0.060	0.060	0.049	0.049	0.049	0.049	0.049	0.049	0.000
New Jersey	-0.005	-0.005	-0.007	-0.007	-0.007	-0.007	-0.007	-0.007	0.000
New Mexico	-0.046	-0.047	-0.048	-0.048	-0.048	-0.048	-0.056	-0.056	0.000
New York	-0.022	-0.022	-0.022	-0.022	-0.022	-0.022	-0.024	-0.024	0.000
North Carolina	-0.004	-0.005	-0.065	-0.065	-0.067	-0.067	-0.100	-0.143	0.000
North Dakota	-0.045	-0.045	-0.046	-0.046	-0.060	-0.060	-0.086	-0.193	0.000
Ohio	-0.014	-0.017	-0.076	-0.076	-0.076	-0.076	-0.078	-0.082	0.000
Oklahoma	-0.001	-0.002	-0.003	-0.003	-0.003	-0.003	-0.012	-0.018	0.000
Oregon	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.000
Pennsylvania	0.008	0.007	-0.023	-0.023	-0.023	-0.023	-0.027	-0.028	0.000
Rhode Island	-0.019	-0.019	-0.019	-0.019	-0.019	-0.019	-0.019	-0.019	0.000
South Carolina	-0.016	-0.016	-0.041	-0.041	-0.041	-0.041	-0.041	-0.041	0.000
South Dakota	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.000
Tennessee	0.022	0.022	0.019	0.019	0.019	0.019	0.018	0.018	0.000
Texas	0.010	0.007	0.002	0.002	0.002	0.002	-0.017	-0.037	0.000
Utah	0.013	-0.039	-0.039	-0.039	-0.039	-0.039	-0.032	-0.086	0.000
Vermont	0.011	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.000
Virginia	0.049	0.049	0.048	0.044	0.047	0.043	0.042	0.034	0.000
Washington	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.027	0.000
West Virginia	-0.040	-0.043	-0.067	-0.076	-0.074	-0.082	-0.083	-0.125	0.000
Wisconsin	0.008	0.005	0.002	0.002	0.002	0.002	0.001	0.001	0.000
Wyoming	0.066	0.066	0.064	0.045	0.064	0.045	-0.015	-0.089	0.000
Tribal Data	0.081	0.081	0.081	0.081	0.081	0.081	-0.011	-0.187	0.000

Table D-9. 2024 Fractional Difference in Emissions Relative to 2023 Air Quality Modeling Base Case for Each State.

State	Eng Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR+ SCR	Optimize SNCR+ SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB	Straight Line Interpolation
Alabama	0.011	0.011	0.011	0.010	0.011	0.010	0.010	0.007	-0.021
Arizona	-0.023	-0.030	-0.041	-0.041	-0.041	-0.041	-0.036	-0.056	-0.036
Arkansas	-0.042	-0.043	-0.042	-0.042	-0.042	-0.042	-0.087	-0.129	-0.028
California	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.016
Colorado	-0.038	-0.038	-0.038	-0.038	-0.038	-0.038	-0.052	-0.072	-0.018
Connecticut	-0.041	-0.043	-0.044	-0.044	-0.044	-0.044	-0.044	-0.044	-0.024
Delaware	-0.024	-0.024	-0.027	-0.027	-0.027	-0.027	-0.028	-0.028	-0.020
District of Columbia	-0.033	-0.033	-0.033	-0.033	-0.033	-0.033	-0.033	-0.033	-0.033
Florida	0.016	0.016	0.004	0.004	0.004	0.004	-0.002	-0.008	-0.025
Georgia	-0.010	-0.010	-0.010	-0.010	-0.010	-0.010	-0.011	-0.011	-0.023
Idaho	-0.013	-0.013	-0.013	-0.013	-0.013	-0.013	-0.013	-0.013	-0.035
Illinois	-0.042	-0.042	-0.043	-0.043	-0.044	-0.044	-0.052	-0.055	-0.020
Indiana	-0.081	-0.083	-0.114	-0.114	-0.114	-0.114	-0.122	-0.128	-0.022
Iowa	-0.095	-0.097	-0.112	-0.113	-0.112	-0.113	-0.145	-0.194	-0.028
Kansas	-0.059	-0.059	-0.068	-0.068	-0.069	-0.069	-0.076	-0.093	-0.024
Kentucky	0.118	0.118	0.113	0.089	0.112	0.088	0.055	0.006	-0.023
Louisiana	0.079	0.078	0.078	0.078	0.072	0.072	0.068	0.052	-0.012
Maine	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	-0.023
Maryland	-0.042	-0.042	-0.042	-0.042	-0.042	-0.042	-0.049	-0.049	-0.022
Massachusetts	-0.014	-0.014	-0.014	-0.014	-0.014	-0.014	-0.015	-0.015	-0.018
Michigan	-0.036	-0.044	-0.049	-0.049	-0.049	-0.049	-0.062	-0.077	-0.015
Minnesota	-0.053	-0.055	-0.060	-0.060	-0.060	-0.060	-0.078	-0.086	-0.031
Mississippi	0.169	0.169	0.169	0.159	0.169	0.159	0.140	0.121	-0.020
Missouri	-0.063	-0.063	-0.077	-0.077	-0.078	-0.078	-0.082	-0.101	-0.029
Montana	-0.022	-0.022	-0.022	-0.022	-0.022	-0.022	-0.050	-0.081	-0.028
Nebraska	-0.060	-0.062	-0.061	-0.061	-0.061	-0.061	-0.092	-0.132	-0.026
Nevada	0.015	-0.014	-0.032	-0.032	-0.032	-0.032	-0.040	-0.052	-0.034
New Hampshire	0.036	0.036	0.025	0.025	0.025	0.025	0.025	0.025	-0.025
New Jersey	-0.028	-0.028	-0.030	-0.030	-0.030	-0.030	-0.030	-0.030	-0.022
New Mexico	-0.067	-0.068	-0.069	-0.069	-0.069	-0.069	-0.077	-0.077	-0.022
New York	-0.043	-0.043	-0.044	-0.044	-0.044	-0.044	-0.045	-0.045	-0.023
North Carolina	-0.027	-0.028	-0.088	-0.088	-0.090	-0.090	-0.123	-0.166	-0.031
North Dakota	-0.064	-0.064	-0.065	-0.065	-0.079	-0.079	-0.105	-0.213	-0.020
Ohio	-0.036	-0.040	-0.099	-0.099	-0.099	-0.099	-0.100	-0.104	-0.022
Oklahoma	-0.020	-0.021	-0.023	-0.023	-0.023	-0.023	-0.031	-0.037	-0.016
Oregon	-0.021	-0.021	-0.021	-0.021	-0.021	-0.021	-0.021	-0.021	-0.033
Pennsylvania	-0.010	-0.011	-0.041	-0.041	-0.041	-0.041	-0.045	-0.046	-0.022
Rhode Island	-0.045	-0.045	-0.045	-0.045	-0.045	-0.045	-0.045	-0.045	-0.027
South Carolina	-0.043	-0.043	-0.067	-0.067	-0.067	-0.067	-0.067	-0.067	-0.024
South Dakota	-0.035	-0.035	-0.036	-0.036	-0.036	-0.036	-0.035	-0.035	-0.045
Tennessee	-0.003	-0.003	-0.006	-0.006	-0.006	-0.006	-0.008	-0.008	-0.025
Texas	-0.011	-0.014	-0.018	-0.018	-0.019	-0.019	-0.036	-0.055	-0.017
Utah	-0.008	-0.060	-0.061	-0.061	-0.061	-0.061	-0.054	-0.107	-0.022
Vermont	-0.024	-0.024	-0.024	-0.024	-0.024	-0.024	-0.024	-0.024	-0.035
Virginia	0.018	0.018	0.017	0.013	0.016	0.012	0.011	0.004	-0.022
Washington	0.008	0.008	0.008	0.008	0.008	0.008	0.008	-0.006	-0.033
West Virginia	-0.049	-0.052	-0.076	-0.085	-0.083	-0.091	-0.092	-0.134	-0.007
Wisconsin	-0.033	-0.035	-0.038	-0.038	-0.038	-0.038	-0.039	-0.039	-0.027
Wyoming	0.055	0.055	0.052	0.034	0.052	0.034	-0.027	-0.100	-0.020
Tribal Data	0.082	0.082	0.082	0.082	0.082	0.082	-0.009	-0.186	0.001

Table D-10. 2025 Fractional Difference in Emissions Relative to 2023 Air Quality Modeling Base Case for Each State.

State	Eng Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR+ SCR	Optimize SNCR+ SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB	Straight Line Interpolation
Alabama	-0.015	-0.015	-0.015	-0.016	-0.015	-0.016	-0.016	-0.019	-0.043
Arizona	-0.055	-0.062	-0.072	-0.072	-0.072	-0.072	-0.068	-0.088	-0.071
Arkansas	-0.066	-0.067	-0.066	-0.066	-0.066	-0.066	-0.111	-0.153	-0.055
California	-0.022	-0.022	-0.023	-0.023	-0.023	-0.023	-0.023	-0.023	-0.032
Colorado	-0.055	-0.055	-0.055	-0.055	-0.055	-0.055	-0.069	-0.089	-0.037
Connecticut	-0.064	-0.066	-0.067	-0.067	-0.067	-0.067	-0.067	-0.067	-0.047
Delaware	-0.046	-0.046	-0.048	-0.048	-0.048	-0.048	-0.049	-0.049	-0.041
District of Columbia	-0.066	-0.066	-0.066	-0.066	-0.066	-0.066	-0.066	-0.066	-0.065
Florida	-0.013	-0.013	-0.025	-0.025	-0.026	-0.026	-0.031	-0.037	-0.050
Georgia	-0.036	-0.036	-0.036	-0.036	-0.036	-0.036	-0.037	-0.037	-0.047
Idaho	-0.049	-0.049	-0.049	-0.049	-0.049	-0.049	-0.049	-0.049	-0.071
Illinois	-0.063	-0.063	-0.064	-0.064	-0.065	-0.065	-0.073	-0.076	-0.041
Indiana	-0.104	-0.106	-0.136	-0.136	-0.136	-0.136	-0.144	-0.150	-0.043
Iowa	-0.122	-0.125	-0.140	-0.141	-0.140	-0.141	-0.172	-0.221	-0.057
Kansas	-0.081	-0.082	-0.091	-0.091	-0.092	-0.092	-0.099	-0.116	-0.047
Kentucky	0.075	0.075	0.070	0.052	0.070	0.052	0.022	-0.022	-0.046
Louisiana	0.067	0.066	0.066	0.066	0.060	0.060	0.056	0.039	-0.025
Maine	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	-0.046
Maryland	-0.065	-0.065	-0.065	-0.065	-0.065	-0.065	-0.072	-0.072	-0.044
Massachusetts	-0.032	-0.032	-0.032	-0.032	-0.033	-0.033	-0.033	-0.033	-0.037
Michigan	-0.053	-0.062	-0.066	-0.066	-0.066	-0.066	-0.079	-0.094	-0.030
Minnesota	-0.077	-0.079	-0.085	-0.085	-0.085	-0.085	-0.103	-0.110	-0.063
Mississippi	0.147	0.147	0.147	0.137	0.147	0.137	0.118	0.099	-0.041
Missouri	-0.091	-0.092	-0.106	-0.106	-0.107	-0.107	-0.110	-0.130	-0.058
Montana	-0.049	-0.049	-0.049	-0.049	-0.049	-0.049	-0.077	-0.108	-0.056
Nebraska	-0.088	-0.090	-0.089	-0.089	-0.089	-0.089	-0.120	-0.160	-0.052
Nevada	-0.017	-0.046	-0.065	-0.065	-0.065	-0.065	-0.072	-0.085	-0.068
New Hampshire	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.000	-0.049
New Jersey	-0.051	-0.051	-0.054	-0.054	-0.054	-0.054	-0.054	-0.054	-0.044
New Mexico	-0.088	-0.089	-0.090	-0.090	-0.090	-0.090	-0.098	-0.098	-0.044
New York	-0.064	-0.064	-0.065	-0.065	-0.065	-0.065	-0.066	-0.066	-0.045
North Carolina	-0.063	-0.064	-0.124	-0.124	-0.125	-0.125	-0.158	-0.191	-0.062
North Dakota	-0.083	-0.084	-0.084	-0.084	-0.098	-0.098	-0.124	-0.232	-0.040
Ohio	-0.059	-0.063	-0.121	-0.121	-0.121	-0.121	-0.123	-0.127	-0.044
Oklahoma	-0.040	-0.040	-0.042	-0.042	-0.042	-0.042	-0.051	-0.057	-0.032
Oregon	-0.054	-0.054	-0.054	-0.054	-0.054	-0.054	-0.054	-0.054	-0.066
Pennsylvania	-0.028	-0.028	-0.059	-0.059	-0.059	-0.059	-0.063	-0.064	-0.043
Rhode Island	-0.072	-0.072	-0.072	-0.072	-0.072	-0.072	-0.072	-0.072	-0.054
South Carolina	-0.068	-0.068	-0.092	-0.092	-0.092	-0.092	-0.092	-0.092	-0.048
South Dakota	-0.080	-0.081	-0.081	-0.081	-0.081	-0.081	-0.081	-0.081	-0.089
Tennessee	-0.039	-0.039	-0.039	-0.039	-0.039	-0.039	-0.041	-0.041	-0.050
Texas	-0.028	-0.031	-0.035	-0.035	-0.036	-0.036	-0.053	-0.072	-0.033
Utah	-0.029	-0.081	-0.082	-0.082	-0.082	-0.082	-0.075	-0.129	-0.044
Vermont	-0.059	-0.059	-0.059	-0.059	-0.059	-0.059	-0.059	-0.059	-0.070
Virginia	-0.004	-0.005	-0.005	-0.010	-0.007	-0.011	-0.012	-0.019	-0.045
Washington	-0.025	-0.025	-0.025	-0.025	-0.025	-0.025	-0.025	-0.039	-0.067
West Virginia	-0.058	-0.061	-0.085	-0.094	-0.092	-0.100	-0.101	-0.143	-0.013
Wisconsin	-0.067	-0.069	-0.072	-0.072	-0.072	-0.072	-0.073	-0.073	-0.054
Wyoming	0.043	0.043	0.040	0.022	0.040	0.022	-0.038	-0.112	-0.040
Tribal Data	0.084	0.084	0.084	0.084	0.084	0.084	-0.007	-0.184	0.001

Table D-11. 2023 Ozone Season Anthropogenic NO_X Emissions Reductions (Tons) for non-EGUs and Fractional Difference in Emissions for the non-EGU Scenario Relative to the 2023 Air Quality Modeling Base Case for Each State.

State	Non-EGU glass and cement, refined analysis, others unchanged, below $2,000/ton (Tons)	Fractional Difference EGU $1,800/ton +non-EGU tranche 1 glass & cement analyzed
Alabama	-	0.035
Arizona	-	-0.009
Arkansas	-	-0.018
California	-	0.005
Colorado	-	-0.009
Connecticut	-	-0.021
Delaware	-	-0.006
District of Columbia	-	-0.001
Florida	-	0.028
Georgia	-	0.016
Idaho	-	0.022
Illinois	464	-0.027
Indiana	666	-0.063
Iowa	-	-0.086
Kansas	-	-0.046
Kentucky	-	0.111
Louisiana	-	0.085
Maine	-	0.048
Maryland	-	-0.023
Massachusetts	-	0.004
Michigan	-	-0.029
Minnesota	-	-0.036
Mississippi	-	0.182
Missouri	-	-0.050
Montana	-	0.005
Nebraska	-	-0.028
Nevada	-	0.000
New Hampshire	-	0.049
New Jersey	-	-0.007
New Mexico	-	-0.048
New York	238	-0.025
North Carolina	-	-0.067
North Dakota	-	-0.060
Ohio	-	-0.076
Oklahoma	-	-0.003
Oregon	-	0.012
Pennsylvania	-	-0.023
Rhode Island	-	-0.019
South Carolina	-	-0.041
South Dakota	-	0.010
Tennessee	-	0.019
Texas	-	0.002
Utah	-	-0.039
Vermont	-	0.010
Virginia	138	0.040
Washington	-	0.042
West Virginia	-	-0.082
Wisconsin	-	0.002
Wyoming	-	0.045
Tribal Data	-	0.081

3. Description of the analytic results.

For each year 2021-2025, EPA used the ozone AQAT to estimate improvements in downwind air quality at base case levels, at $1,800 per ton emission budget levels, and at higher dollar per ton emission budget levels. At each cost threshold level, using AQAT, EPA examined the average and maximum design values for each of the receptors. EPA evaluated the degree of change in ppb and whether it decreased average or maximum values to below 76 ppb (at which point their nonattainment and maintenance issues, respectively, would be considered resolved). EPA also examined each state's air quality contributions at each emission budget level, assessing whether a state maintained at least one linkage (i.e., greater than or equal to 1% (.75 ppb) to a receptor that was estimated to remain in nonattainment and/or maintenance. EPA examined the engineering base case, $1,600/ton, $1,800/ton, $5,800/ton, and $9,600/ton. EPA also created "straight line" estimates comparable to those used at Steps 1 and 2. The preamble explains at section VI.D how EPA considered the results of the air quality analyses described in this TSD to determine the appropriate emission levels for eliminating significant contribution to nonattainment and interference with maintenance.

For each year, the average and maximum design values (in ppb) estimated using the assessment tool for each identified receptor for each cost threshold level have been rounded to hundredths of a ppb and can be found in Tables D-12 through D-21. There are four monitors, three in Connecticut and one in Texas. Scenarios that are not viable, for technical or policy reasons, have been grayed out in these tables.

In 2021, we observe that the Stratford monitor 090013007 in Fairfield County, Connecticut, switches to maintenance at the $1,600/ton level (where SCRs are optimized). In other words, its average design value drops below 76 ppb (Table D-12), while its maximum design value stays above 76 ppb (Table D-13). The Madison monitor 090099002 in New Haven County, Connecticut, has both its average and maximum design values below 76 at all cost levels, including in the Engineering Base. It was estimated to have a maintenance issue in the 2021 Base Case interpolated from the air quality modeling and used at Steps 1 and 2 (with its maximum design value higher than 76 ppb).

In 2024, there is only one receptor remaining (the Westport monitor 090019003 in Fairfield County, Connecticut). This receptor switches from nonattainment to maintenance at $1,600/ton (Tables D-18 and D-19).

EPA also assessed changes in air quality for the non-EGU scenarios for 2023, 2024, and 2025. In these cases, we included EGU emission reductions at the $1,800/ton cost threshold level. The results are shown in Table D-22.

In the assessment of air quality using the calibrated assessment tool, we are able to estimate the change in the air quality contributions of each upwind state to each receptor (see the description of the state and receptor-specific contributions in section D.2.c.(2)) in order to determine whether any state's contribution is below the 1 percent threshold used in step 2 of the 4-Step Good Neighbor Framework to identify "linked" upwind states. For this over-control assessment, we compared each state's adjusted ozone concentration against the 1% air quality threshold at each of the cost threshold levels up to $9,600/ton at each remaining receptor, using AQAT. To see static air quality contributions and design value estimates for the four receptors of interest for each of the years for each of the cost levels, see the individual worksheets labeled: $9600; $5800; $3900; $1600 w CC & non-EGU; $1600 w CC; $1600 wo CC; $500; straightline_base; and eng_base. For interactive worksheets, refer to the "scenario_202X" worksheets after setting the desired scenario in the "summaryDVs" worksheet. Then, adjust cells J27 and J28 to match the desired scenario of interest. The numbering for the various scenarios is shown in Table D-23. For a cost threshold run, cell J27 would be a value of 1 through 8, while cell J28 should be fixed with a value of 1. For all linked states, in the cost threshold analysis, we did not see any instances where a state's contributions dropped below 1% of the NAAQS for all its linkages to remaining downwind receptors. That is, if a state was linked to a receptor in 2021 in the base case, and that receptor remained either nonattainment or maintenance in other years or at other cost thresholds, the state remained linked with a contribution greater than or equal to 1% of the NAAQS. This is not a surprising result because, for a linkage to be resolved by emission reductions of just a few percent, the original base contribution would need to be within a few percent of the threshold. As a hypothetical example, if the state is making a 6% emission reduction in its overall anthropogenic ozone season NO_X emissions, and the calibration factor was 0.5, its original base case maximum contribution to a remaining unresolved nonattainment and/or maintenance receptor would need to be just under 1.03% of the NAAQS or 0.77 ppb, to drop below the 0.75 ppb linkage threshold.

Lastly, once the EGU budgets for the rule were established (based on the results of the multi-factor test), it was possible to estimate air quality concentrations in the "control scenario" at each downwind receptor for each year using the ozone AQAT (Table D-24). Here, we apply a scenario where all states (regardless of whether they are linked to a particular receptor or to a different receptor in the geography) have the same cost threshold applied as do the "linked" states. We observe very little effect of this on air quality at the receptor and in no case are the changes large enough to shift the status of a receptor from either nonattainment to maintenance or from maintenance to attainment. This is not surprising because the contributions to each receptor from these non-linked states are already below the 1% threshold.

Table D-12. 2021 Average Ozone DVs (ppb) for NOx Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Average Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR+ SCR	Optimize SNCR+ SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	74.3	76.50	76.13	76.11	75.95	75.93	75.94	75.93	75.89	75.83
90019003	CT	Fairfield	76.9	78.56	78.27	78.26	78.13	78.12	78.13	78.12	78.08	78.03
90099002	CT	New Haven	71.7	73.98	73.59	73.57	73.40	73.38	73.39	73.37	73.32	73.25
482010024	TX	Harris	74.0	75.51	75.62	75.58	75.51	75.51	75.50	75.50	75.25	74.95

Note: Scenarios that are not viable, for technical or policy reasons, have been grayed out

Table D-13. 2021 Maximum Ozone DVs (ppb) for NOx Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Maximum Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	75.2	77.43	77.05	77.03	76.87	76.85	76.86	76.85	76.81	76.75
90019003	CT	Fairfield	77.2	78.86	78.58	78.57	78.44	78.43	78.43	78.42	78.39	78.34
90099002	CT	New Haven	73.8	76.15	75.74	75.72	75.54	75.53	75.54	75.52	75.47	75.39
482010024	TX	Harris	75.6	77.15	77.25	77.21	77.15	77.15	77.13	77.13	76.88	76.57

Table D-14. 2022 Average Ozone DVs (ppb) for NOx Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Average Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	74.3	75.40	75.16	75.14	74.98	74.97	74.97	74.96	74.92	74.87
90019003	CT	Fairfield	76.9	77.73	77.55	77.54	77.41	77.39	77.40	77.39	77.36	77.31
90099002	CT	New Haven	71.7	72.84	72.58	72.56	72.39	72.37	72.38	72.37	72.32	72.25
482010024	TX	Harris	74.0	74.76	74.98	74.94	74.88	74.88	74.87	74.87	74.61	74.32

Table D-15. 2022 Maximum Ozone DVs (ppb) for NOx Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Maximum Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	75.2	76.31	76.07	76.05	75.89	75.87	75.88	75.87	75.83	75.77
90019003	CT	Fairfield	77.2	78.03	77.85	77.84	77.71	77.70	77.70	77.69	77.66	77.61
90099002	CT	New Haven	73.8	74.98	74.71	74.69	74.51	74.49	74.50	74.49	74.44	74.36
482010024	TX	Harris	75.6	76.37	76.60	76.56	76.50	76.50	76.48	76.48	76.23	75.92

Table D-16. 2023 Average Ozone DVs (ppb) for NO$_X$ Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Average Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR+ SCR	Optimize SNCR+ SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	74.3	74.30	74.13	74.11	73.88	73.86	73.87	73.86	73.80	73.72
90019003	CT	Fairfield	76.9	76.90	76.74	76.72	76.48	76.46	76.48	76.46	76.39	76.31
90099002	CT	New Haven	71.7	71.70	71.51	71.48	71.24	71.21	71.23	71.21	71.14	71.03
482010024	TX	Harris	74.0	74.00	74.55	74.49	74.38	74.38	74.36	74.36	73.95	73.46

Table D-17. 2023 Maximum Ozone DVs (ppb) for NO$_X$ Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Maximum Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	75.2	75.20	75.03	75.01	74.78	74.76	74.77	74.75	74.69	74.61
90019003	CT	Fairfield	77.2	77.20	77.04	77.02	76.78	76.76	76.78	76.76	76.69	76.60
90099002	CT	New Haven	73.8	73.80	73.60	73.58	73.32	73.30	73.32	73.29	73.22	73.12
482010024	TX	Harris	75.6	75.60	76.17	76.10	75.99	75.99	75.97	75.97	75.55	75.05

Table D-18. 2024 Average Ozone DVs (ppb) for NO$_X$ Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Average Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	74.3	73.76	73.58	73.56	73.33	73.31	73.32	73.30	73.25	73.17
90019003	CT	Fairfield	76.9	76.38	76.20	76.18	75.94	75.92	75.94	75.92	75.86	75.78
90099002	CT	New Haven	71.7	71.14	70.93	70.90	70.66	70.63	70.65	70.63	70.56	70.46
482010024	TX	Harris	74.0	73.58	74.05	73.98	73.88	73.88	73.86	73.86	73.47	73.01

Table D-19. 2024 Maximum Ozone DVs (ppb) for NO$_X$ Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Maximum Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	75.2	74.65	74.47	74.45	74.22	74.20	74.21	74.19	74.14	74.06
90019003	CT	Fairfield	77.2	76.68	76.50	76.48	76.24	76.22	76.23	76.22	76.15	76.07
90099002	CT	New Haven	73.8	73.22	73.01	72.98	72.73	72.70	72.72	72.70	72.62	72.53
482010024	TX	Harris	75.6	75.17	75.65	75.58	75.48	75.48	75.46	75.46	75.06	74.59

Table D-20. 2025 Average Ozone DVs (ppb) for NOX Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Average Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	74.3	73.22	73.04	73.02	72.79	72.77	72.79	72.77	72.72	72.64
90019003	CT	Fairfield	76.9	75.86	75.68	75.66	75.42	75.41	75.42	75.40	75.34	75.26
90099002	CT	New Haven	71.7	70.58	70.37	70.35	70.10	70.08	70.09	70.07	70.00	69.91
482010024	TX	Harris	74.0	73.16	73.62	73.55	73.45	73.45	73.43	73.43	73.04	72.59

Table D-21. 2025 Maximum Ozone DVs (ppb) for NOX Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Maximum Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	75.2	74.11	73.93	73.91	73.67	73.66	73.67	73.65	73.60	73.52
90019003	CT	Fairfield	77.2	76.16	75.98	75.96	75.72	75.70	75.71	75.70	75.64	75.56
90099002	CT	New Haven	73.8	72.65	72.43	72.41	72.15	72.13	72.14	72.12	72.05	71.96
482010024	TX	Harris	75.6	74.74	75.21	75.14	75.04	75.04	75.02	75.02	74.62	74.16

Table D-22. Average and Maximum Ozone DVs (ppb) for non-EGU NOX Emissions Level* for Each Year Assessed.

Monitor Identification Number	State	County	CAMx 2023 Base Case Avg DV (ppb)	Average Design Value (ppb)			Maximum Design Value (ppb)		
				2023	2024	2025	2023	2024	2025
90013007	CT	Fairfield	74.3	73.83	73.28	72.74	74.72	74.16	73.62
90019003	CT	Fairfield	76.9	76.43	75.89	75.37	76.73	76.19	75.67
90099002	CT	New Haven	71.7	71.17	70.60	70.04	73.26	72.66	72.09
482010024	TX	Harris	74.0	74.36	73.86	73.43	75.97	75.46	75.02

*non-EGU AQAT air quality estimates include EGU emission reductions at the $1,600/ton level.

Table D-23. Description of the Various Scenarios Modeled in AQAT.

Scenario	Cost Threshold Level	Short Description	Description
1	$0	Eng base	Baseline 202x OS NOx + engineering nonCEMs
2	$500	$500	Baseline 202x OS NOx + engineering nonCEMs + $500/ton Generation Shifting
3	$1,600	$1,600 w/o LNB	Baseline 202x OS NOx + engineering nonCEMs + 0.08 SCR Cap + $1,600/ton Generation Shifting
4	$1,600	$1,600 w LNB	Baseline 202x OS NOx + engineering nonCEMs + 0.08 SCR Cap + LNB + $1,600/ton Generation Shifting

5	$1,800	$1,800 w/o LNB	Baseline 202x OS NOx + engineering nonCEMs + 0.08 SCR Cap + SNCR Optimize + $1,600/ton Generation Shifting
6	$1,800	$1,800 w LNB	Baseline 202x OS NOx + engineering nonCEMs + 0.08 SCR Cap + LNB + SNCR Optimize + $1,600/ton Generation Shifting
7	$5,800	$5,800	Baseline 202x OS NOx + engineering nonCEMs + 0.08 SCR Cap + LNB + SNCR Optimize + SNCR Retrofit + $5,800/ton Generation Shifting
8	$9,600	$9,600	Baseline 202x OS NOx + engineering nonCEMs + 0.08 SCR Cap + LNB + SNCR Optimize + SCR Retrofit + $9,600/ton Generation Shifting
~~9~~	NA	Straightline base	202X Straight line emissions interpolation (an appoximation of that used for Steps 1 and 2).
10	NA		Analyzed…number of tons of non-EGU glass and cement, refined analysis.
11	$1,800 up to $2,000	$1,800 w LNB & non-EGU	Baseline 202x OS NOx + engineering nonCEMs + 0.08 SCR Cap + LNB + SNCR Optimize + $1,600/ton Generation Shifting + non-EGU glass and cement, refined analysis, others unchanged, below $2,000 per ton.

Table D-24. Average and Maximum Ozone DVs (ppb) for the $1,800 Per Ton "Control Scenario" for each Year Assessed.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Average Design Value (ppb)					Maximum Design Value (ppb)				
				2021	2022	2023	2024	2025	2021	2022	2023	2024	2025
90013007	CT	Fairfield	74.3	75.94	74.96	73.85	73.30	72.77	76.86	75.87	74.75	74.19	73.65
90019003	CT	Fairfield	76.9	78.13	77.39	76.45	75.92	75.40	78.43	77.69	76.75	76.21	75.69
90099002	CT	New Haven	71.7	73.39	72.37	71.20	70.62	70.07	75.54	74.48	73.29	72.69	72.12
482010024	TX	Harris	74.0	75.50	74.86	74.36	73.86	73.43	77.13	76.48	75.97	75.45	75.02

4. Comparison between the air quality assessment tool estimates

As described earlier, AQAT was calibrated using CAMx data from either 2016 or 2028. Thus, it was possible to evaluate the estimates from the tool for a comparable scenario. The average design values from AQAT for 2024 for the various scenarios are shown using the 2016-based calibration factor (Table D-25), as well as the differences between the values in Tables D-18 and D-25. The differences are shown in Table D-26. The AQAT values and the differences in the table have been rounded to a hundredth of a ppb. For this set of scenarios, the differences are moderate, with a maximum value of 0.51 ppb.

There can be a small offset between the estimates (based on the impacts of the two different calibration factors). Within a set of estimates, the differences are likely to be comparable. That is, comparing two different scenarios in Table D-18 with the same two scenarios in Table D-25, produces similar changes in air quality. For example, the difference between the engineering base and the $1,800 per ton level where SCR and SNCR are optimized and combustion controls are installed results in a difference of 0.29 ppb when the 2028 calibration factor is applied and 0.19 ppb when the 2016 calibration factor is applied. The results of this demonstrate that, considering the time and resource constraints faced by the EPA, the AQAT provides reasonable estimates of air quality concentrations for each receptor, can provide reasonable inputs for the multi-factor assessment, and can serve as a method to test for linkages dropping below the threshold.

Table D-25. 2024 Average Ozone DVs (ppb) for NO_X Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors Using the Calibration Factor from the 2016 Modeling.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Average Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	74.3	73.76	73.79	73.78	73.61	73.60	73.61	73.60	73.56	73.50
90019003	CT	Fairfield	76.9	76.38	76.52	76.50	76.38	76.36	76.37	76.36	76.33	76.28
90099002	CT	New Haven	71.7	71.14	71.15	71.14	70.96	70.95	70.96	70.94	70.89	70.82
482010024	TX	Harris	74.0	73.58	74.03	73.99	73.93	73.93	73.91	73.91	73.68	73.40

Table D-26. 2024 Difference in Average Ozone DVs (ppb) for NO_X Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors for the Estimates with the Two Different Calibration Factors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Average Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	74.3	0.16	0.21	0.22	0.28	0.29	0.29	0.29	0.31	0.33
90019003	CT	Fairfield	76.9	0.23	0.31	0.32	0.43	0.44	0.43	0.44	0.47	0.51
90099002	CT	New Haven	71.7	0.16	0.23	0.23	0.30	0.31	0.31	0.31	0.33	0.36
482010024	TX	Harris	74.0	0.16	-0.02	0.01	0.05	0.05	0.06	0.06	0.21	0.38

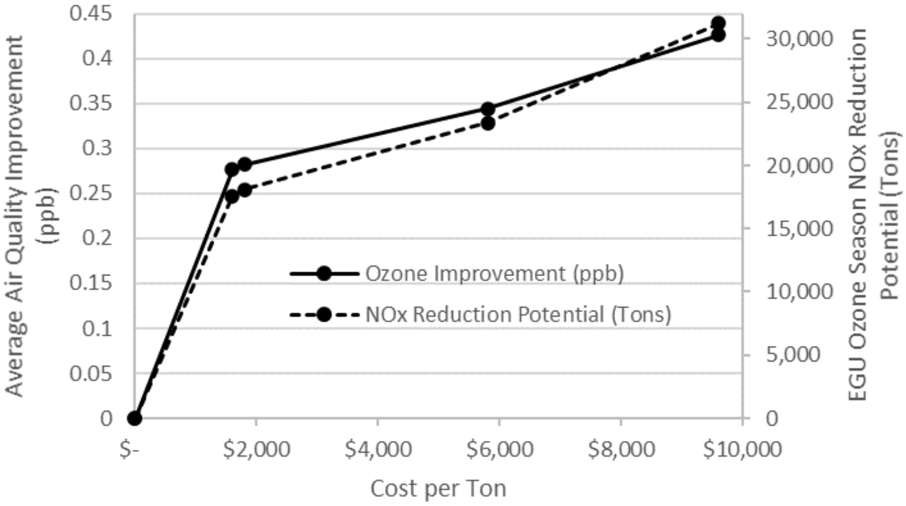
E. Observations on Cost and Air Quality Factors in 2024

Section VI of the preamble discusses the cost and air quality factors in the multifactor test and reaches the conclusions about the requisite level of emissions control for each year. The higher mitigation technology scenarios associated with post-combustion control installation were not considered in the 2021 multi-factor test as they pertain to technologies not possible to install at a regional scale until 2025. However, for illustrative purposes, EPA examined their reduction potential and air quality impact of these controls starting in 2024. As described in sections C and D of this TSD, EPA quantified emissions from upwind states at various levels of uniform NO_X control stringency, each represented by uniform control technology and corresponding NO_X reduction and then evaluated the potential air quality consequences of these potential reductions.

EPA combines costs, EGU NO_X reductions, corresponding improvements in downwind ozone concentrations, and other considerations for different control levels in its multi-factor test. EPA examines whether any receptor shifts from nonattainment to maintenance or from maintenance to attainment. In 2024, the last receptor (Westport) in Fairfield Connecticut shifts from nonattainment to maintenance at $1,600 per ton. This receptor is minimally above the

75.9 threshold in 2024 and is fully resolved by 2025. No additional changes are observed at higher cost threshold levels in 2024 or 2025. EPA analysis of these more stringent scenarios in 2024 also results in a “knee-in-the-curve” graph (see preamble section VI for details about this figure for 2021). Figure E-1 below illustrates the air quality improvement for the mitigation technologies up to $9,600 per ton for EGUs for 2024. In Figure E-1, the 2024 “knee” is also at a point where emission budgets reflect a control stringency with an estimated marginal cost of $1,600 and $1,800 per ton. The more stringent emission budget levels (e.g., emission budgets reflecting mitigation technologies that cost $5,800 per ton or greater) yield fewer additional emission reductions and fewer air quality improvements relative to the increase in control costs. These control measures also involve significant capital investment and the installation of new hardware at the EGU. For the reasons described in section VI of the preamble, the $1,800 per ton cost threshold is a reasonable stopping level for 2021 and 2022. Although EPA evaluated the potential reductions from post combustion controls, that technology did not qualify as an option for future years as EPA explains those controls are not possible on a regional scale until 2025, and EPA expects no remaining air quality problems for the 2008 ozone NAAQS standard in that year at the $1,800 per ton level.

Figure E-1. EGU Ozone Season NOX Reduction Potential in 11 Linked States and Corresponding Total Reductions in Downwind Ozone Concentration at the Westport Fairfield Connecticut Receptor for each Cost Threshold Level Evaluated in 2024.



F. Assessment of the Effects of Ozone on Forest Health[39]

Air pollution can impact the environment and affect ecological systems, leading to changes in the ecological community and influencing the diversity, health, and vigor of individual plant species. When ozone is present in the environment, it enters the plant through the stomata and can interfere with carbon gain (photosynthesis) and allocation of carbon within the plant, making fewer carbohydrates available for plant growth, reproduction, and/or yield (2020 PA, section 4.3.1 and 2013 ISA, p. 1-15).[40],[41] Ozone can impact a variety of commercial and ecologically important species throughout the United States. These include forest tree and herbaceous species as well as crops. Such effects at the plant scale can also be linked to an array of effects at larger spatial scales and higher levels of biological organization, causing impacts to ecosystem productivity, water cycling, ecosystem community composition and alteration of below-ground biogeochemical cycles (2020 PA, section 4.3.1 and 2013 ISA, p. 1-15)..[42] With the data sets available to the Agency, here, we focus on selected forest tree species.

Assessing the impact of ozone on forests in the United States involves understanding the risk to tree species from ozone concentrations in ambient air and accounting for the prevalence of those species within the forest. Across several reviews of the ozone NAAQS and based on longstanding body of scientific evidence, EPA has evaluated concentration-response functions which relate ozone exposure to growth-related effects in order to consider the risk of ozone-related growth impacts on forest trees (2020 PA, section 4.3.3, 2013 ISA and 2020 ISA). For this purpose, EPA has focused on cumulative, concentration-weighted indices of exposure, such as the W126-based cumulative exposure index (2020 PA, section 4.3.3.1.1, 2020 ISA, section ES.3). Measured ozone concentrations in ambient air of the United States are used to calculate the W126-based index as the annual maximum 3-month sum of daytime hourly weighted ozone concentrations, averaged over 3 consecutive years. The sensitivity of different trees species varies about the growth impacts of ozone exposure. Based on well-studied datasets relating W126 index to reduced growth, exposure response functions have been developed for 11 tree species (2020 PA, section 4.3.3.1.2 and Figure 4-3 and 2013 ISA, section 9.6). For these species, the impact from ozone exposure has been determined by exposing seedlings to different levels of ozone concentrations over one or more seasons (which have been summarized in terms of W126 index) and measuring reductions in growth (which are then summarized as "relative biomass loss"). The magnitude of ozone impact on a forest community will depend on the

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[39] Analysis of the environmental effects of ozone is not within scope of the Revised CSAPR Update rule. *See* Legal section of the Response to Comments document for further information.

[40] U.S. EPA (2020). Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards. U.S. Environmental Protection Agency. Office of Air Quality Planning and Standards, Health and Environmental Impacts Division, Research Triangle Park, NC. EPA-452/R-20-001. Available *https://www.epa.gov/sites/production/files/2020-05/documents/o3-final_pa-05-29-20compressed.pdf*

[41] U.S. EPA (2020). Integrated Science Assessment for Ozone and Related Photochemical Oxidants. U.S. Environmental Protection Agency. Washington, DC. Office of Research 3A-35 and Development. EPA/600/R-20/012. Available at: *https://www.epa.gov/isa/integrated-science-assessment-isa-ozone-and-related-photochemical-oxidants*.

[42] U.S. EPA (2013). Integrated Science Assessment of Ozone and Related Photochemical Oxidants (Final Report). Office of Research and Development, National Center for Environmental Assessment. Research Triangle Park, NC. U.S. EPA. EPA-600/R-10-076F. February 2013. Available at: *https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100KETF.txt*.

prevalence of different tree species of relatively more versus less sensitivity to ozone and the abundance in the community.

The most common tree species in the eastern United States, where the benefits from this rule will be most pronounced, are black cherry (*Prunus serotina*), yellow or tulip-poplar (*Liriodendron tulipifera*), sugar maple (*Acer saccharum*), eastern white pine (*Pinus strobus*), Virginia Pine (*Pinus virginiana*), red maple (*Acer rubrum*), and quaking aspen (*Populus trenuloides*). Since 2008, EPA has assessed the impact of ozone on these tree species within the eastern United States for the period from 2000 to 2018 as part of the Clean Air Market Division (CAMD) annual power sector programs progress report.[43] Over this time period ozone concentrations have improved substantially because of various emission reduction programs, such as NBP, CAIR, CSAPR, CSAPR Update, and other local and mobile source reductions such as Tier2 and Tier3 rules. Past EPA assessments have shown that the improvements in ozone are evident both for the regulatory metric, 3-year average of 4th highest 8-hr daily maximum ozone concentration, and for the W126 metric. [44] In forests where certain sensitive species dominate the forest community, the estimates of relative biomass loss from ozone have decreased substantially. However, for the period from 2017–2019, the eastern United States still has areas with up to 11.5% estimated relative biomass loss for the seven tree species – black cherry, yellow poplar, sugar maple, eastern white pine, Virginia pine, red maple, and quaking aspen (Figure F-1)[45].

Ozone levels are expected to continue to decrease through 2024 based on model projection of the impacts on ozone concentrations resulting from baseline "on the books" control programs as well as by emission reductions under this rule. As ozone declines, estimates of relative biomass loss of these trees' species will also decline as they have from 2000 to 2019, indicating increased protection of forest ecosystems and resources. Under this rule, ozone concentrations are expected to decline faster than without the rule (e.g., under the base case). While EPA does not have the tools to quantify the expected level of improvement at this time, based on the previous relationships between ozone design values and W126 determined as part of the review of the 2020 ozone NAAQS (2020 PA, section 4D.3.2.3 and Table 4D-12), W126 values are expected to improve as design values decrease. As described in the preamble, the rule is expected to decrease design values by 0.17 ppb, on average, in 2021. The reductions from this

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[43] See the annual progress report at https://www3.epa.gov/airmarkets/progress/reports/index.html

[44] U.S. EPA (2020). Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards. U.S. Environmental Protection Agency. Office of Air Quality Planning and Standards, Health and Environmental Impacts Division, Research Triangle Park, NC. EPA-452/R-20-001. Available *https://www.epa.gov/sites/production/files/2020-05/documents/o3-final_pa-05-29-20compressed.pdf*

[45] To estimate the biomass loss for forest ecosystems across the eastern United States, the biomass loss for each of the seven tree species was calculated using the three-month, 12-hour W126 exposure metric at each location, along with each tree's individual C-R functions. The W126 exposure metric was calculated using monitored ozone data from CASTNET and AQS sites, and a three-year average was used to minimize the effect of variations in meteorological and soil moisture conditions. The biomass loss estimate for each species was then multiplied by its prevalence in the forest community using the U.S. Department of Agriculture (USDA) Forest Service IV index of tree abundance calculated from Forest Inventory and Analysis (FIA) measurements.

rule are likely to provide further protection to natural forest ecosystems by reducing the potential for ozone-related impacts.

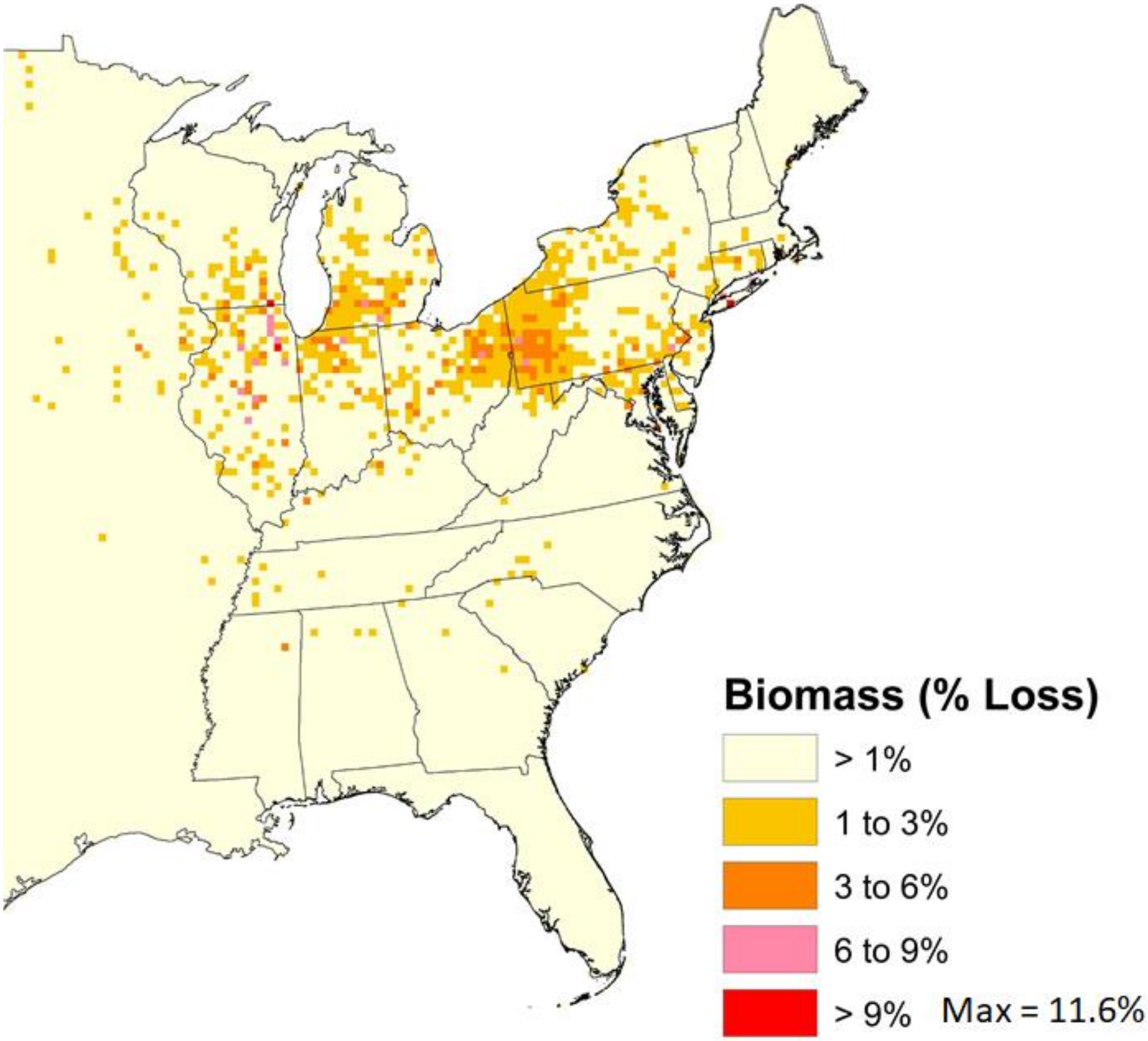

Figure F-1: Estimated Black Cherry, Yellow Poplar, Sugar Maple, Eastern White Pine, Virginia Pine, Red Maple, and Quaking Aspen Biomass Loss due to Ozone Exposure for 2016-2018. See the annual progress report at https://www3.epa.gov/airmarkets/progress/reports/index.html

Appendix A: State Emission Budget Calculations and Engineering Analytics

See Excel workbook titled “Final Rule State Emission Budget Calculations and Engineering Analytics” on EPA’s website and in the docket for this rulemaking

Appendix B: Description of Excel Spreadsheet Data Files Used in the AQAT

EPA placed the Ozone_AQAT_Final.xlsx Excel workbook file in the Revised CSAPR Update docket that contains all the emission and CAMx air quality modeling inputs and resulting air quality estimates from the AQAT. The following bullets describe the contents of various worksheets within the AQAT workbook:

State-level emissions

- "2021_EGU" through "2026_EGU" contain EGU emissions measurements and estimates for each state. Various columns contain the 2016 and 2019 OS measured emissions, CSAPR Update Budgets, and then emissions for the engineering base along with each of the cost thresholds.
- "2016fh1" contains state and source-sector specific ozone-season NO_X emission totals for the 2016 base case modeled in CAMx.
- "2023fh1" contains state and source-sector specific ozone-season NO_X emission totals for the 2023 base case with EGU estimates from IPM modeled in CAMx.
- "2023fh1_eng" contains state and source-sector specific ozone-season NO_X emission totals for the 2023 base case with EGU estimates from engineering analysis that could be used in CAMx.
- "2028fh1" contains state and source-sector specific ozone-season NO_X emission totals for the 2028 base case with EGU estimates from IPM modeled in CAMx.
- "AQM_EGU_emiss" has a breakdown of the point EGU emission inventory used in the air quality modeling, for the units with CEMs and those that don't (nonCEMs).
- "calib_emiss" has the total anthropogenic emissions by state for each of the base cases modeled in CAMx. This worksheet also contains the fraction change for each of these scenarios relative to the 2023fh1 base case modeled in CAMx.
- "2021_emiss_total", "2022_emiss_total", "2023_emiss_total", "2024_emiss_total", "2025_emiss_total", "2026_emiss_total" each of these worksheets reconstructs total anthropogenic emissions for the year, with various EGU emission inventories for different cost threshold (including the engineering base case). The total anthropogenic emissions can be found for each state in columns BW through CE. These totals are then compared to the 2023fh1 emission level (column CE) to make a fractional change in emissions in columns CF through CN. Non-EGU emissions change and fractional change (inclusive of EGU changes at $1,800/ton) are found in columns CO and CP, respectively

Air quality modeling design values and contributions from CAMx

- "2023_contribs" contains average and maximum design values as well as state by state contributions for the 2023fh1 base case modeled in CAMx.
- "2028fh1 DVs" contains average and maximum design values for each receptor in 2028 with EGU estimates from IPM.

Calibration factor creation and assessment

- "calib_2016" includes the calculation of the calibration factor based on the 2023 contributions, and percent change of 2016 emissions relative to 2023 emissions. The calibration factor can be found in column BM.

- “calib_2028” includes the calculation of the calibration factor based on the 2023 contributions, and percent change of 2028 emissions relative to 2023 emissions. The calibration factor can be found in column BM.
- “calib comp” includes a summary of the three calibration factors (one based on 2016and one based on 2028).

Air quality estimates

- ”Summary DVs” contains the average and maximum design value estimates (rounded to two decimal places) for receptors that were nonattainment or maintenance in the 2021 base case interpolation modeling. Values for each year (2021 through 2015), for each cost threshold are shown. Grey or black filled cells are not considered viable scenarios for technical or policy reasons. Each scenario has the cost threshold shown for that run the linked and unlinked states. Adjustment to cells J27 and J28will result in interactive adjustment for the other worksheets and will adjust the average design values in column J and maximum design values in column X.
- “scenario_2021” through “scenario_2025” contains the average and maximum design value estimates (as well as the individual state’s air quality contributions) for a particular scenario identified in cells G2 and G3. The fractional emission changes for each of the linked and unlinked states are shown in rows 2 and 3.
- “scenario_2021_sens” and “scenario_2022_sens” contains the average and maximum design value estimates (as well as the individual state’s air quality contributions) for a particular EGU scenario identified in cells G2 and G3 where the remainder of the emission inventory was created by interpolating between a projected 2021 inventory and the 2023 inventory. The fractional emission changes for each of the linked and unlinked states are shown in rows 2 and 3. The fractional emission changes for these scenarios are calculated in “2021_emiss_total_sens” and “2021_emiss_total_sens”.
- “straightline_2021” through “straightline_2026” contains the average and maximum design value estimates (as well as the individual state’s air quality contributions) for the emissions scenario that is a linear interpolation of the emissions between the 2016 base case and the 2023fh1 base case (or between the 2023fh1 base case and 2028fh1 base case).
- “control_2021” through “contol_2025” contains the average and maximum design value estimates (as well as the individual state’s air quality contributions) for a particular scenario identified in cells G2 and G3. States that are “linked” to any receptor in the geography are assigned the values in row 2 while nonlinked states are assigned the values in row 3. Note that, as the “home” States, Texas and Connecticut are both assigned the “linked” State level of reductions.
- “scenario_2024 alt calibration” contains the average and maximum design value estimates (as well as the individual state’s air quality contributions) for a particular scenario identified in cells G2 and G3. The fractional emission changes for each of the linked and unlinked states are shown in rows 2 and 3. This uses the calibration factor based on the 2016 air quality modeling, rather than the calibration factor based on the 2028 air quality modeling.
- The individual cost level worksheets labeled: “New_SCR”; “New_SNCR”; “SCR_SNCR_LNB”; “SCR_SNCR”; “SCR_LNB”; “SCR”; “$500”; “straightline_base”;

and “eng_base” contain static air quality contributions and design value estimates for the four receptors of interest for each of the years.

Appendix C: IPM Runs Used in Transport Rule Significant Contribution Analysis

Table C-1 lists IPM runs used in analysis for this rule. The IPM runs can be found in the docket for this rulemaking under the IPM file name listed in square brackets in the table below.

Table Appendix C-1. IPM Runs Used in Transport Rule Significant Contribution Analysis

Run Name **[IPM File Name]**	**Description**
Air Quality Modeling Base Case EPA617_BC_75L	Model run used for the air quality modeling base case at steps 1 and 2, which includes the national Title IV SO2 cap-and-trade program; NO_X SIP Call; the Cross-State Air Pollution trading programs, and settlements and state rules. It also includes key fleet updates regarding new units, retired units, and control retrofits that were known by Fall of 2019.
Illustrative Base Case EPA617_CURR_1g	Model run used as the base case for the Illustrative Analysis of cost threshold analyses. Based on the air quality modeling base case, but with projected retirements and retrofits in 2021 limited.
Illustrative Base Case with optimization technology + LNB upgrade EPA617_CURR_5d	Imposes state-level generation constraints starting in 2021 for fossil-fuel fired units greater than 25 MW that is equal to Illustrative Base Case levels. Also assumes optimization of existing post-combustion controls and upgrade of combustion controls if mode 3<mode 1.
Illustrative $1,600 per ton Cost Threshold EPA617_CURR_3d	Same as the Illustrative Base Case with optimization technology + LNB upgrade, but with $1600/ OS NOx ton price signal applied in the ozone season.
Illustrative $3,900 per ton Cost Threshold EPA617_CURR_4d	Same as the Illustrative Base Case with optimization technology + LNB upgrade, but with $3900/OS NOx ton price signal applied in the ozone season.
Illustrative Base Case with optimization technology, LNB, + SNCR retrofit EPA617_CURR_8d	Same as Illustrative Base Case with optimization technology + LNB upgrade , but starting in 2025, for coal fired units greater than 100 MW and lacking a post combustion NO_x control (SCR or SNCR), a 25% reduction to their ozone season NO_x emission rate with a floor of 0.07 lbs/MMBtu is applied.
Illustrative $5,800 per ton Cost Threshold EPA617_CURR_6d	Same as Illustrative Base Case with optimization technology, LNB, + SNCR retrofit, but with $5,800 OS NOx ton price signal applied in the ozone-season
Illustrative Base Case with optimization technology, LNB, + SCR retrofit EPA617_CURR_9d	Same as Illustrative Base Case with optimization technology + LNB upgrade, but starting in 2025, for coal fired units greater than 100 MW and lacking a post combustion NO_x control (SCR or SNCR), a 90%reduction to their ozone season NO_x emission rate with a floor of 0.07 lbs/MMBtu is applied.
Illustrative $9,600 per ton Cost Threshold EPA617_CURR_7d	Same as Illustrative Base Case with optimization technology, LNB, + SCR retrofit, but with $9,600/OS NOx ton OS ton price signal applied in the ozone-season.
Illustrative $500 per ton Cost ThresholdEPA617_CURR_10d	Same as Illustrative Base Case, but with $500/OS NOx ton OS ton price signal applied in the ozone-season.

Illustrative More Stringent Policy Case EPA617_CURR_13	Same as Illustrative Base Case, but with ozone season emissions budgets with variability limits applied for the 12 states reflecting $1600 per OS NOx ton through 2023 and $9600 per OS NOx ton for 2025 model run year, along with a regional cap equal to the sum of the 12 states' budgets for each year.
Illustrative LessStringent Policy Case EPA617_CURR_12	Same as Illustrative Base Case, but with ozone season emissions budgets with variability limits applied for the 12 states reflecting $500 per OS NOx ton starting in 2021, along with a regional cap equal to the sum of the 12 states' budgets for each year.
Proposed Policy Scenario EPA617_CURR_14	Same as Illustrative Base Case, but with ozone season emissions budgets with variability limits applied for the 12 states reflecting $1600 per OS NOx ton starting in 2021, along with a regional cap equal to the sum of the 12 states' budgets for each year.
Final Illustrative More Stringent Policy Case EPA617_CURR_20e	Same as Illustrative Base Case, but with ozone season emissions budgets with variability limits applied for the 12 states reflecting optimization of existing controls and combustion control upgrade through 2023, and SCR retrofit in model run year 2025 and beyond, along with a regional cap equal to the sum of the 12 states' budgets for each year.
Final Illustrative LessStringent Policy Case EPA617_CURR_21b	Same as Illustrative Base Case, but with ozone season emissions budgets with variability limits applied for the 12 states reflecting $500 per OS NOx ton starting in 2021, along with a regional cap equal to the sum of the 12 states' budgets for each year.
Final Policy Scenario EPA617_CURR_19d	Same as Illustrative Base Case, but with ozone season emissions budgets with variability limits applied for the 12 states reflecting $1600 and $1800 per OS NOx ton starting in 2021and 2022 respectively, along with a regional cap equal to the sum of the 12 states' budgets for each year.
Final Policy Sensitivity **EPA617_CURR_22**	Same as Final Policy Scenario used for RIA, but with state emission budgets reflecting $1800 per ton stating in 2021
Base Case with Additional Nuclear Retirements – Sensitivity **EPA617_CURR_18b**	Same as Illustrative Base Case, but with potential Dresden/Byron nuclear retirements included.
Final Policy Scenario Sensitivity – with additional nuclear retirements **EPA617_CURR_23**	Same as Final Policy Scenario assumptions, but applied to the base case with additional nuclear retirements to reflect potential Dresden/Byron nuclear retirements.

Appendix D: Ozone-Season NO_X Emissions Limits for IPM Modeling

Table Appendix D-1. State and Regional Caps for IPM Final Case Analysis for the Final Rule

	Policy Case				Less Stringent Case ($500/ton)				More Stringent Case ($9,600/ton)		
	Assurance Level (121% of Budget)				Assurance Level (121% of Budget)				Assurance Level (121% of Budget)		
	2021*[46]	2023	2025		2021	2023	2025		2021	2023	2025
Illinois	11,129	9,896	9,751		11,311	10,155	10,009		11,129	9,896	8,338
Indiana	15,833	15,189	11,573		18,969	18,366	14,621		15,833	15,189	10,201
Kentucky	18,521	17,001	17,001		18,883	18,883	18,883		18,521	17,001	11,827
Louisiana	18,621	17,929	17,929		18,670	18,670	18,670		18,621	17,929	15,272
Maryland	1,814	1,532	1,631		1,816	1,533	1,633		1,814	1,532	1,414
Michigan	15,406	12,070	11,841		15,882	12,567	12,327		15,406	12,070	8,887
New Jersey	1,517	1,517	1,517		1,629	1,629	1,629		1,517	1,517	1,521
New York	4,133	4,139	4,117		4,190	4,196	4,174		4,133	4,139	3,989
Ohio	11,725	11,825	11,825		18,740	18,839	18,839		11,725	11,825	11,158
Pennsylvania	10,139	10,131	10,131		14,287	14,285	14,285		10,139	10,131	9,499
Virginia	5,583	4,816	4,432		5,640	5,272	4,866		5,583	4,816	3,853
West Virginia	16,560	15,589	15,589		18,170	18,170	18,170		16,560	15,589	12,787
Region Cap (Budget Total)	108,248	100,525	96,974		122,468	117,822	114,138		108,248	100,525	81,609

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[46] As explained in the RIA, the modeled budgets represented here in the 2021 policy and more stringent scenario are approximately 1% higher than the final rule budgets due to the rulemaking schedule limitations for beginning the RIA analysis.

Appendix E: Generation Shifting Analysis

Table Appendix E-1. Tons of EGU NO$_X$ Reduction Potential from Shifting Generation Compared to Adjusted Historical Baseline Emissions.

	2021			2022			2023			2024		
	Baseline (tons)	Reductions from generation shifting at $1600 per ton (tons)	Reductions from generation shifting (%)	Baseline (tons)	Reductions from generation shifting at $1600 per ton (tons)	Reductions from generation shifting (%)	Baseline (tons)	Reductions from generation shifting at $1600 per ton (tons)	Reductions from generation shifting (%)	Baseline (tons)	Reductions from generation shifting at $1600 per ton (tons)	Reductions from generation shifting (%)
Illinois	9,368	52	1%	9,368	52	1%	8,413	53	1%	8,292	52	1%
Indiana	15,856	317	2%	15,383	313	2%	15,357	316	2%	12,232	265	2%
Kentucky	15,588	-11	0%	15,588	-12	0%	15,588	-12	0%	15,588	-12	0%
Louisiana	15,476	87	1%	15,476	87	1%	15,476	87	1%	15,476	87	1%
Maryland	1,501	2	0%	1,267	1	0%	1,267	1	0%	1,350	2	0%
Michigan	13,898	1,167	8%	13,459	1,164	9%	11,182	1,203	11%	10,968	1,177	11%
New Jersey	1,346	-1	0%	1,346	-1	0%	1,346	-1	0%	1,346	-1	0%
New York	3,469	53	2%	3,469	53	2%	3,474	53	2%	3,456	53	2%
Ohio	15,829	315	2%	15,927	330	2%	15,927	330	2%	15,927	330	2%
Pennsylvania	11,896	361	3%	11,896	367	3%	11,896	367	3%	11,896	367	3%
Virginia	4,664	48	1%	4,274	47	1%	4,361	51	1%	4,025	48	1%
West Virginia	15,165	105	1%	15,165	104	1%	15,165	104	1%	15,165	104	1%
Total	**124,057**	**2,493**	**2%**	**122,619**	**2,506**	**2%**	**119,453**	**2,551**	**2%**	**115,722**	**2,471**	**2%**

Appendix F: Feasibility Assessment for Engineering Analytics Baseline

Similar to CSAPR Update Final Action, EPA analyzed and confirmed that the assumed fleet operations in its baseline emissions and budget estimates were compatible with future load requirements by verifying that new units in addition to the existing fleet would provide enough generation, assuming technology-specific capacity factors, to replace the retiring generation expected to occur in years 2021 through 2024. EPA assessed generation adequacy specific to the 12 states covered under this action. EPA uses these observations to determine whether any assumed replacement generation from the existing fleet is necessary to offset the announced retirements and continue to satisfy electricity load. Additionally, EPA looked at whether the combination of new units (both fossil and non-fossil) provide sufficient new generation to replace retiring generation. In this case, EPA found that the new unit generation from fossil and renewable generation would exceed the generation from retiring units in all three scenarios examined, indicating that no further replacement generation from existing units is needed. Moreover, EPA found the change in generation from the covered fossil units to be within the observed historical trend. EPA updated its analysis below at final rule taking into account the latest announcements and commenter data on new units and retirements. EPA's conclusion was further supported by its updated analysis and data.

- EPA first identified the collective baseline heat input and generation from the 12 states covered in this action and compared it to historical trends for these same states (Scenario 1). This illustrated that the assumed heat input and generation from fleet turnover was well within with recent historical trends (see tables Appendix F-1,Appendix F-2, and Appendix F-3 below).
- EPA then compared the collective baseline heat input and generation from the 12 states covered in this action to a scenario where fossil generation remains at 2019 levels instead of continuing to decline (Scenario 2).
- Finally, EPA identified the 2020 Energy Information Administration's Annual Energy Outlook (EIA AEO) annual growth projections from 2019 through 2024 total electricity demand levels (0.8%) from its reference case, and estimated an upperbound future year scenario where covered fossil generation grew at levels matching this fleet-wide total growth rate (Scenario 3).[47]
- EPA's assessment illustrates the amount of generation in its baseline, factoring in retirements and new fossil units, is more than sufficient to accommodate all three scenarios.[48] For instance, generation from covered fossil sources in these 12 states has dropped at an average rate greater than 2% per year between 2016 and 2019 (410 TWh to

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[47] Department of Energy, Annual Energy Outlook 2020. Available at https://www.eia.gov/outlooks/aeo/data/browser/#/?id=8-AEO2020&cases=ref2020&sourcekey=0

[48] Based on historical trends, modeling, and company statements, EPA expects levels similar to scenario 1 and scenario 2 to be most likely.

384 Twh). However, EPA's assumed baseline generation from covered fossil sources for the 12 states reflects a rate of decline less than 2% per year. See Table Appendix F-2.

- EPA then identified new RE capacity under construction, testing, or in site prep by 2021. For years beyond 2021, EPA also identified new RE capacity that was planned but with regulatory approvals pending for years 2022 and beyond (as this capacity is unlikely to have yet started construction).[49]
- EPA calculated and added the RE generation values to the fossil baseline to estimate future year generation in the state (see Table Appendix F-3). EPA used a capacity factor of 42.7% for wind, 21.6% for solar, and 65% for NGCC.
- Using these technology-specific capacity factors based on past performance and IPM documentation, EPA anticipated over 20 TWh from new generation already under construction or being planned with regulatory approval received. This combined with the baseline generation from existing units exceeds the expected generation load for the 12 states under all three scenarios.[50]
- Not only is the future baseline generation level assumed in EPA's engineering analysis well within the recent historical fossil generation trend (See Table Appendix F-2) on its own (which illustrates no need for replacement generation), but it is also exceeds an upper bound analysis for future covered fossil generation that assumes 0.8% growth from the existing fossil fleet (scenario 3). Moreover, the potential new generation from RE (over 7 TWh) when added to the baseline fossil generation values further increases the amount by which baseline generation exceeds the historical fossil generation for the 12 states with assumed annual growth of 0.8%. This indicates that available capacity and generation assumed would serve load requirements in this upper bound scenario.

  Not included in the tables below nor in EPA's baseline, but listed in the latest EIA 860m is even more planned NGCC combined cycle for years 2023 and 2024 that is pending regulatory approval. Assuming some of this (low emitting generation) becomes available in the outer years, that constitutes additional generation that exceeds EPA's upperbound generation levels below – further bolstering the observation that no replacement generation from existing units needs to be assumed to fill generation from retiring units.

Table Appendix F-1: Heat Input Change Due to Fleet Turnover (Historical and Future)

	Reported Heat Input from Covered Fossil Units (TBtu)					Assumed Heat Input from Covered Fossil (TBtu)			
	2016	2017	2018	2019		2021	2022	2023	2024
Illinois	383.4	333.2	379.3	311.8		267	267	270	266
Indiana	415.6	379.1	432.3	356.5		357	352	356	297

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[49] Department of Energy, EIA Form 860, Generator Form 3-1. 2019 Early Release. Available at https://www.eia.gov/electricity/data/eia860/

[50] While EPA notes the baseline generation exceeds the covered fossil load in all three scenarios in Table F-3, EPA anticipates scenarios 1 and 2 being more representative of likely covered fossil load based on historical trends, future modeling, and utility resource plans.

Kentucky	360.2	319.1	351.3	313.8		287	287	287	287
Louisiana	331.8	302	312.2	317.4		344	345	345	345
Maryland	108.7	76.9	95.7	83		82	79	79	94
Michigan	331.5	317	344.4	316.1		315	315	325	318
New Jersey	178.7	145.1	150.8	144.9		145	145	145	145
New York	269.7	199.7	228.6	195.6		227	227	228	228
Ohio	429	401	392.2	391.2		376	394	394	394
Pennsylvania	515.8	473.1	460.1	485.2		517	526	526	526
Virginia	259.9	228.2	241	237.9		249	246	261	252
West Virginia	323.1	324	303.6	287.9		285	285	285	285
Total	**3,907**	**3,498**	**3,692**	**3,441**		**3,450**	**3,468**	**3,501**	**3,437**

Table Appendix F-2: Generation Change Due to Fleet Turnover (Historical and Future)

	Reported Generation from Covered Fossil Units (TWh)				Assumed Generation from Covered Fossil (TWh)			
State	2016	2017	2018	2019	2021	2022	2023	2024
Illinois	38.6	33.9	38.7	32.7	28.3	28.3	29.6	29.2
Indiana	42.7	39.4	45.8	38.8	38.8	38.4	39.0	33.8
Kentucky	37.1	33.8	37.2	33.6	31.0	31.0	31.0	31.0
Louisiana	36	33.1	34.6	36.1	39.8	39.9	39.9	39.9
Maryland	11	7.9	10.4	9.5	9.4	9.1	9.1	11.5
Michigan	31.8	30.8	34	31.7	31.6	31.7	35.2	34.5
New Jersey	20.5	17.2	18.2	18	18.0	18.0	18.0	18.0
New York	30	22.5	25.6	22.5	26.4	26.4	26.5	26.5
Ohio	47.9	45.1	45.5	45.8	44.4	46.9	46.9	46.9
Pennsylvania	53.6	49.7	49.8	56.8	62.1	63.6	63.6	63.6
Virginia	27.8	25.5	27.1	28.9	30.8	30.8	33.3	32.4
West Virginia	33.9	33.8	31.8	29.9	29.9	29.9	29.9	29.9
Total	**410.9**	**372.7**	**398.7**	**384.3**	**390.5**	**394.0**	**402.0**	**397.2**

Table Appendix F-3: Assumed Baseline OS Generation and Expected New Build Generation from Covered Fossil Units (TWh)

	2019	**2020**	**2021**	**2022**	**203**	**2024**
Scenario 1 - Generation Levels (with continued pace of 2% decline)	384.2	376.5	369.0	361.6	354.4	347.3
Scenario 2 - Generation Levels (no change from 2019)	384.2	384.2	384.2	384.2	384.2	384.2
Scenario 3 - Generation Levels (.8% growth from covered fossil)	384.2	387.3	390.4	393.5	396.6	399.8
Assumed Baseline Fossil Generation with Reported Fossil Retirement and Reported New Build			390.5	394.0	402.0	397.2

New Build (Non-Fossil)			4.6	7.2	7.2	7.2
Total Baseline Generation			**395.1**	**401.2**	**409.2**	**404.4**

Appendix G: State Emission Budgets and Variability Limits

Table Appendix G-1: State Emission Budgets and Variability Limits (tons)

	2021		2022		2023		2024	
State	**Emission Budgets**	**Variability Limit**	**Emission Budgets**	**Variability Limit**	**Emission Budgets**	**Variability Limit**	**Emission Budgets**	**Variability Limit**
Illinois	9,102	1,911	9,102	1,911	8,179	1,718	8,059	1,692
Indiana	13,051	2,741	12,582	2,642	12,553	2,636	9,564	2,008
Kentucky	15,300	3,213	14,051	2,951	14,051	2,951	14,051	2,951
Louisiana	14,818	3,112	14,818	3,112	14,818	3,112	14,818	3,112
Maryland	1,499	315	1,266	266	1,266	266	1,348	283
Michigan	12,727	2,673	12,290	2,581	9,975	2,095	9,786	2,055
New Jersey	1,253	263	1,253	263	1,253	263	1,253	263
New York	3,416	717	3,416	717	3,421	718	3,403	715
Ohio	9,690	2,035	9,773	2,052	9,773	2,052	9,773	2,052
Pennsylvania	8,379	1,760	8,373	1,758	8,373	1,758	8,373	1,758
Virginia	4,516	948	3,897	818	3,980	836	3,663	769
West Virginia	13,334	2,800	12,884	2,706	12,884	2,706	12,884	2,706

Appendix H: AQAT Estimates for the 2021 and 2022 Sensitivity Cases

EPA performed a series of sensitivity scenarios using an inventory based on 2021 and one (for 2022) interpolated between 2021 and 2023. The fractional change in emissions are shown below. Scenarios that are not viable, for technical or policy reasons, have been grayed out in these tables.

Table H-1. 2021 Fractional Difference in Emissions Relative to 2023 Air Quality Modeling Base Case for Each State.

State	**Eng Baseline**	**$500/ ton**	**Optimize SCR**	**Optimize SCR + LNB**	**Optimize SNCR+ SCR**	**Optimize SNCR+ SCR + LNB**	**New SNCR + Optimize SNCR+ SCR + LNB**	**New SCR + Optimize SNCR+ SCR + LNB**	**Straight Line Interpolation**
Alabama	0.094	0.094	0.094	0.092	0.094	0.092	0.092	0.090	0.140
Arizona	0.062	0.056	0.045	0.045	0.045	0.045	0.050	0.030	0.160
Arkansas	0.055	0.053	0.054	0.054	0.054	0.054	0.010	-0.033	0.136
California	0.096	0.096	0.095	0.095	0.095	0.095	0.095	0.095	0.132
Colorado	0.033	0.033	0.033	0.033	0.032	0.032	0.014	-0.017	0.117
Connecticut	0.044	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.138
Delaware	0.052	0.052	0.050	0.050	0.050	0.050	0.048	0.048	0.131
District of Columbia	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.129
Florida	0.083	0.083	0.070	0.070	0.070	0.070	0.064	0.058	0.182
Georgia	0.098	0.098	0.098	0.098	0.098	0.098	0.097	0.097	0.162
Idaho	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.136
Illinois	0.031	0.030	0.029	0.029	0.028	0.028	0.020	0.017	0.111
Indiana	0.045	0.042	0.011	0.011	0.010	0.010	-0.003	-0.019	0.164
Iowa	0.021	0.019	0.004	0.003	0.004	0.003	-0.029	-0.078	0.107
Kansas	0.022	0.022	0.012	0.012	0.011	0.011	0.004	-0.013	0.088
Kentucky	0.189	0.190	0.184	0.160	0.184	0.160	0.126	0.077	0.201
Louisiana	0.126	0.125	0.125	0.125	0.120	0.120	0.115	0.099	0.091
Maine	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.131
Maryland	0.007	0.007	0.007	0.007	0.007	0.007	0.001	-0.002	0.166
Massachusetts	0.024	0.024	0.024	0.024	0.024	0.024	0.023	0.023	0.109
Michigan	0.055	0.047	0.042	0.041	0.042	0.041	0.028	0.013	0.100
Minnesota	0.090	0.088	0.081	0.081	0.081	0.081	0.062	0.054	0.120
Mississippi	0.264	0.264	0.264	0.254	0.264	0.254	0.235	0.216	0.188
Missouri	0.040	0.039	0.026	0.026	0.025	0.025	0.021	0.002	0.161
Montana	0.098	0.098	0.098	0.098	0.098	0.098	0.070	0.039	0.116
Nebraska	0.057	0.055	0.056	0.044	0.056	0.044	0.013	-0.029	0.103
Nevada	0.140	0.109	0.089	0.089	0.089	0.089	0.069	0.030	0.173
New Hampshire	0.103	0.103	0.092	0.092	0.092	0.092	0.092	0.092	0.147
New Jersey	0.044	0.044	0.042	0.042	0.042	0.042	0.042	0.042	0.157
New Mexico	0.057	0.057	0.054	0.054	0.054	0.054	0.042	0.005	0.091
New York	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.011	-0.011	0.105
North Carolina	-0.065	-0.065	-0.065	-0.065	-0.065	-0.065	-0.065	-0.065	-0.052
North Dakota	0.051	0.050	-0.010	-0.010	-0.012	-0.012	-0.045	-0.089	0.093
Ohio	0.084	0.082	0.081	0.081	0.067	0.067	0.025	-0.093	0.077
Oklahoma	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.034
Oregon	0.045	0.042	-0.017	-0.017	-0.017	-0.017	-0.018	-0.023	0.125
Pennsylvania	0.038	0.037	0.035	0.035	0.035	0.035	0.026	0.021	0.054
Rhode Island	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.134
South Carolina	0.004	0.004	-0.027	-0.027	-0.027	-0.027	-0.031	-0.031	0.122
South Dakota	0.039	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.136
Tennessee	0.038	0.038	0.014	0.014	0.014	0.014	0.013	0.013	0.128
Texas	0.135	0.135	0.135	0.135	0.135	0.135	0.135	0.135	0.167
Utah	0.075	0.075	0.072	0.072	0.072	0.072	0.070	0.070	0.163
Vermont	0.063	0.060	0.055	0.055	0.055	0.055	0.037	0.016	0.095
Virginia	0.076	0.076	0.076	0.076	0.076	0.076	-0.015	-0.192	0.580
Washington	0.055	0.003	0.002	0.002	0.002	0.002	0.009	-0.044	0.142
West Virginia	0.088	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.143

Wisconsin	0.100	0.100	0.099	0.094	0.097	0.093	0.093	0.085	0.176
Wyoming	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.091	0.148
Tribal Data	-0.016	-0.019	-0.044	-0.053	-0.050	-0.059	-0.059	-0.102	0.042

Table H-2. 2022 Fractional Difference in Emissions Relative to 2023 Air Quality Modeling Base Case for Each State.

State	**Eng Baseline**	**$500/ton**	Optimize SCR	**Optimize SCR + LNB**	Optimize SNCR+ SCR	**Optimize SNCR+ SCR + LNB**	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB	**Straight Line Interpolation**
Alabama	0.065	0.065	0.065	0.064	0.065	0.064	0.064	0.061	0.070
Arizona	0.035	0.029	0.018	0.018	0.018	0.018	0.023	0.003	0.080
Arkansas	0.019	0.017	0.018	0.018	0.018	0.018	-0.026	-0.069	0.068
California	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.066
Colorado	0.019	0.019	0.018	0.018	0.018	0.018	0.000	-0.031	0.059
Connecticut	0.013	0.010	0.010	0.010	0.010	0.010	0.009	0.009	0.069
Delaware	0.024	0.024	0.022	0.022	0.022	0.022	0.021	0.021	0.066
District of Columbia	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.065
Florida	0.062	0.062	0.050	0.050	0.050	0.050	0.044	0.038	0.091
Georgia	0.062	0.062	0.061	0.061	0.061	0.061	0.061	0.061	0.081
Idaho	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.068
Illinois	0.010	0.010	0.008	0.008	0.007	0.007	-0.001	-0.004	0.055
Indiana	0.009	0.007	-0.025	-0.025	-0.025	-0.025	-0.037	-0.051	0.082
Iowa	-0.014	-0.016	-0.031	-0.032	-0.031	-0.032	-0.065	-0.113	0.053
Kansas	-0.007	-0.007	-0.017	-0.017	-0.017	-0.017	-0.025	-0.041	0.044
Kentucky	0.165	0.165	0.160	0.136	0.160	0.136	0.102	0.053	0.100
Louisiana	0.108	0.108	0.108	0.108	0.102	0.102	0.098	0.081	0.046
Maine	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.065
Maryland	-0.012	-0.012	-0.012	-0.012	-0.012	-0.012	-0.018	-0.018	0.083
Massachusetts	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.055
Michigan	0.030	0.022	0.017	0.017	0.017	0.017	0.004	-0.011	0.050
Minnesota	0.040	0.038	0.032	0.032	0.032	0.032	0.012	0.005	0.060
Mississippi	0.228	0.228	0.228	0.218	0.228	0.218	0.199	0.180	0.094
Missouri	0.005	0.004	-0.010	-0.010	-0.011	-0.011	-0.014	-0.033	0.080
Montana	0.046	0.046	0.046	0.046	0.046	0.046	0.018	-0.013	0.058
Nebraska	0.021	0.019	0.020	0.008	0.020	0.008	-0.023	-0.065	0.051
Nevada	0.073	0.043	0.024	0.024	0.024	0.024	0.016	0.004	0.086
New Hampshire	0.081	0.081	0.070	0.070	0.070	0.070	0.070	0.070	0.073
New Jersey	0.020	0.020	0.017	0.017	0.017	0.017	0.017	0.017	0.078
New Mexico	0.033	0.033	0.030	0.030	0.030	0.030	0.018	-0.019	0.046
New York	-0.015	-0.015	-0.016	-0.016	-0.016	-0.016	-0.017	-0.017	0.052
North Carolina	-0.032	-0.032	-0.032	-0.032	-0.032	-0.032	-0.032	-0.032	-0.026
North Dakota	0.020	0.019	-0.041	-0.041	-0.043	-0.043	-0.076	-0.119	0.047
Ohio	0.049	0.048	0.046	0.046	0.033	0.033	-0.010	-0.128	0.038
Oklahoma	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.017
Oregon	0.016	0.013	-0.046	-0.046	-0.046	-0.046	-0.048	-0.052	0.062
Pennsylvania	0.019	0.018	0.016	0.016	0.016	0.016	0.007	0.002	0.027
Rhode Island	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.067
South Carolina	0.006	0.005	-0.025	-0.025	-0.025	-0.025	-0.029	-0.030	0.061
South Dakota	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.068

Tennessee	0.011	0.011	-0.014	-0.014	-0.014	-0.014	-0.014	-0.014	0.064
Texas	0.073	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.083
Utah	0.049	0.049	0.046	0.046	0.046	0.046	0.044	0.044	0.081
Vermont	0.037	0.034	0.029	0.029	0.029	0.029	0.010	-0.010	0.048
Virginia	0.079	0.078	0.078	0.078	0.078	0.078	-0.013	-0.190	0.290
Washington	0.034	-0.018	-0.019	-0.019	-0.019	-0.019	-0.011	-0.065	0.071
West Virginia	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.072
Wisconsin	0.070	0.070	0.070	0.065	0.068	0.064	0.063	0.056	0.088
Wyoming	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.059	0.074
Tribal Data	-0.028	-0.031	-0.055	-0.064	-0.062	-0.070	-0.071	-0.113	0.021

Table H-3. 2021 Average Ozone DVs (ppb) for NO_X Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Average Ozone Design Values (ppb).									
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	74.3	76.50	74.77	74.76	74.59	74.58	74.59	74.58	74.54	74.48
90019003	CT	Fairfield	76.9	78.56	77.26	77.25	77.12	77.11	77.11	77.10	77.07	77.02
90099002	CT	New Haven	71.7	73.98	72.21	72.19	72.02	72.00	72.01	71.99	71.94	71.87
482010024	TX	Harris	74.0	75.51	75.14	75.10	75.03	75.03	75.02	75.02	74.77	74.47

Table H-4. 2021 Maximum Ozone DVs (ppb) for NO_X Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Maximum Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	75.2	77.43	75.68	75.66	75.50	75.48	75.49	75.48	75.44	75.38
90019003	CT	Fairfield	77.2	78.86	77.56	77.55	77.42	77.41	77.41	77.40	77.37	77.32
90099002	CT	New Haven	73.8	76.15	74.32	74.31	74.13	74.11	74.12	74.10	74.05	73.97
482010024	TX	Harris	75.6	77.15	76.76	76.72	76.66	76.66	76.65	76.65	76.39	76.08

Table H-5. 2022 Average Ozone DVs (ppb) for NO_X Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Average Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	74.3	75.40	74.48	74.46	74.30	74.29	74.30	74.28	74.24	74.19
90019003	CT	Fairfield	76.9	77.73	77.04	77.03	76.90	76.89	76.89	76.88	76.85	76.80
90099002	CT	New Haven	71.7	72.84	71.89	71.87	71.70	71.68	71.69	71.68	71.63	71.56
482010024	TX	Harris	74.0	74.76	74.74	74.70	74.64	74.64	74.63	74.63	74.37	74.08

Table H-6. 2022 Maximum Ozone DVs (ppb) for NO$_X$ Emissions Cost Threshold Levels ($/ton) Assessed Using the Ozone AQAT for All Receptors.

Monitor Identification Number	State	County	CAMx 2023 Base Case (ppb)	Assessment Tool Maximum Ozone Design Values (ppb).								
				Straight line	Engineering Baseline	$500/ton	Optimize SCR	Optimize SCR + LNB	Optimize SNCR + SCR	Optimize SNCR + SCR + LNB	New SNCR + Optimize SNCR+ SCR + LNB	New SCR + Optimize SNCR+ SCR + LNB
90013007	CT	Fairfield	75.2	75.38	75.37	75.20	75.19	75.20	75.18	75.14	75.09	75.38
90019003	CT	Fairfield	77.2	77.34	77.33	77.20	77.19	77.19	77.18	77.15	77.10	77.34
90099002	CT	New Haven	73.8	74.00	73.98	73.80	73.78	73.79	73.78	73.73	73.65	74.00
482010024	TX	Harris	75.6	76.36	76.32	76.25	76.25	76.24	76.24	75.98	75.68	76.36