TECHNICAL MEMORANDUM

TO: Docket for Rulemaking, "Revised Cross-State Air Pollution Rule (CSAPR) Update for the 2008 Ozone NAAQS" (EPA-HQ-OAR-2020-0272)
DATE: September 1, 2020
SUBJECT: Assessing Non-EGU Emission Reduction Potential

Introduction

Because there are many types of non-EGU emissions sources or units that emit NOx and many control technologies or combinations of control technologies for these units, there are many approaches to assessing emission reduction potential from non-EGU emissions sources. The EPA completed an assessment of emission reduction potential from these sources on a compressed schedule, and this memorandum presents one approach. The remainder of this memorandum summarizes this approach to assessing non-EGU emission reduction potential and the related air quality impacts associated with the estimated reductions. The memorandum includes the following sections:

- Model and Methodology Used to Assess Non-EGU Emission Reduction Potential
- Background for Determining Source Size/Threshold for Non-EGU Emissions Sources
- Air Quality Impacts from Potential Non-EGU Emissions Reductions
- Further Verifying and Refining Estimated Non-EGU NOx Emissions Reduction Potential
- Detailed Verification and Review of Controls on Non-EGU Sources in Four States
- Conclusions of Verification and Review of Controls on Non-EGU Sources in Four States and Potential Emissions Reductions
- Caveats and Limitations of the Cost Analysis
- Control Installation Timing
- Request for Comment and Additional Information

Model and Methodology Used to Assess Non-EGU Emission Reduction Potential

For this assessment the EPA used the Control Strategy Tool (CoST) with the maximum emission reduction algorithm[1,2,3], the Control Measures Database (CMDb)[4], and the 2023 emissions projections based off of the 2016 NEIv1.[5] We used the maximum emission reduction algorithm to estimate the largest quantity of potential emissions reductions from each emissions source or unit that might impact downwind receptors. CoST also includes a least cost algorithm that works to identify the set of controls that achieves a given percent reduction or target emissions reduction at the least cost. If that target emission reduction can't be achieved, then the resulting strategy will be, by definition, the maximum emissions reduction strategy. That is, the primary objective of the strategy will be focused on getting emissions reductions and not on lowering costs.

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[1] Further information on CoST, including a peer review of the tool, can be found at the following link: https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-analysis-modelstools-air-pollution.

[2] We made a few minor changes to the CoST tool that are not reflected in this assessment. These changes could result in less than 30 additional tpy of potential emissions reductions and ~$2 million less in total costs.

[3] The maximum emission reduction algorithm assigns to each source the single measure (if a measure is available for the source) that provides the maximum reduction to the target pollutant, regardless of cost. For more information, see the CoST User's Guide available at the following link: https://www.cmascenter.org/cost/documentation/3.5/CoST%20User's%20Guide/.

[4] The CMDb is available at the following link: https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-analysis-modelstools-air-pollution.

[5] We used the 2023 inventory files with *fh* in filename.

For 2023, we summarized emissions reductions and average annual cost per ton for the 12 states identified from the 2023 air quality modeling and linked to downwind receptors.[6] The cost per ton values are annual costs and the estimated reductions are annual emissions reductions. In addition, in the assessment CoST applied controls to emissions units with a 150 tons per year (tpy) or more pre-control NOx emissions threshold (see section below on *Background for Determining Source Size for Non-EGU Emissions Sources* for options on NOx emissions thresholds). The results of the CoST run are summarized in an Excel workbook titled *CoST Control Strategy - Max Reduction $10k 150 tpy cutoff 12 States Updated Modeling - No Replace - 07-23-2020*.

The 12 states in this assessment are the 12 states EPA proposes to find linked to a downwind receptor in 2021 in this proposed action: IL, IN, KY, LA, MD, MI, NY, NJ, OH, PA, VA, and WV.

States across the U.S. reported NOx emissions from approximately 81,000 non-EGU facilities with point sources. Of these, states reported control information for facilities with one or more controls for approximately 17,000 non-EGU facilities, or 21 percent of these facilities.[7] As such, this assessment of emission reduction potential from non-EGU emissions sources reflects a large degree of uncertainty because information about existing controls on emissions sources is missing for some states and incomplete for some sources.[8] As an example, Table 1 below includes emissions totals, uncontrolled emissions, and percent of uncontrolled emissions using information from the 2017 NEI.

Table 1. For Facilities w/>150 tpy of Emissions in the 2017 NEI – By State, Total NOx Emissions and Uncontrolled NOx Emissions (ANNUAL tpy)

State	Total Emissions (ANNUAL)	Uncontrolled NOx Emissions (ANNUAL)	Percent of Emissions Uncontrolled
IL	17,655	16,773	95%
IN	32,926	31,567	96%
KY	19,121	16,445	86%
LA	91,952	87,295	95%
MD	6,354	2,339	37%
MI	35,399	34,459	97%
NJ	3,753	2,261	60%
NY	12,418	11,065	89%

[6] In projecting emissions from 2016 to 2023, a percent emissions reduction can be applied to certain emissions units or sources without knowledge of specific controls for those units or sources – these reductions are labeled as being from *unknown measures*. Some of the units or sources included in this assessment had reductions estimated from *unknown measures*. In some cases, CoST removed those *unknown measures* and applied controls to some of those units or sources, resulting in approximately 20 thousand tons of emissions reductions estimated from the CoST-applied controls. Because CoST didn't know what the unknown measures were, CoST might be applying controls that aren't appropriate. In addition, in some cases CoST didn't have a control, so it didn't remove those *unknown measures* and apply controls.

[7] This summary was based on a query of the 2017 NEI.

[8] As noted, control information in the NEI is not consistently provided, but there are two columns that contain control information. The *Control IDs* has a number associated with a control device, and the *% Reduction* has the control efficiency. Either of these columns may be populated, or both, or none. In cases where only the *Control IDs* column is populated and we don't know what the control efficiency is, CoST treats the source as uncontrolled and applies a replacement control. We are likely overestimating potential emissions reductions in these cases. For the 12 states in this assessment there are 488 possible emissions sources to control with pre-control emissions ≥150 tpy. Of these, 130 have something in the *Control IDs* column (which means CoST may be inappropriately applying a control), 129 have something in the *% Reduction* column, and only 28 have both.

State	Total Emissions (ANNUAL)	Uncontrolled NOx Emissions (ANNUAL)	Percent of Emissions Uncontrolled
OH	35,186	33,891	96%
PA	31,680	30,437	96%
VA	19,394	14,317	74%
WV	11,507	11,255	98%

From the CoST run, Table 2 below summarizes potential emissions reductions by industry sector and the range of annual cost per ton estimates across units to which CoST applied controls in each industry sector. This summary can be found in a worksheet titled *Control Summary-by NAICS (2)* in an Excel workbook titled *Control Summary - Max Reduction $10k 150 tpy cutoff 12 States Updated Modeling – No Replace – 05-18-2020*.

Table 2. Annual NOx Emission Reduction Potential and Cost Per Ton Ranges by Industry Sector in 2023 for Twelve States

NAICS Title	NOx Emission Reduction Potential (ANNUAL tpy)	Annual Cost/Ton Range (2016$)
Chemical Manufacturing	11,577	$914 - $9,703
Nonmetallic Mineral Product Manufacturing	19,092	$64 - $4,204
Petroleum and Coal Products Manufacturing	4,363	$2,028 - $8,911
Pipeline Transportation	32,593	$721 - $8,333
Paper Manufacturing	2,058	$3,796 - $8,911
Other	1,846	$212 - $7,963
Utilities	392	$1,279 - $6,046
Primary Metal Manufacturing	6,392	$1,395 - $9,495
Oil and Gas Extraction	2,484	$634 - $5,683

The EPA categorized the CoST results for the control technologies that comprise approximately 92 percent of the total estimated potential emissions reductions from the non-EGU sources in the 2023 projected inventory with 150 tpy or more of NOx emissions in the 12 linked states; the technologies and related emissions sources include:

a. Layered combustion (lean burn IC engines – natural gas),
b. NSCR or layered combustion (industrial natural gas IC engines, SCCs with technology not specified),
c. SCR (glass manufacturing – container, flat & pressed, ICI boilers, IC engines (oil-fired and natural gas)),
d. SNCR (cement manufacturing – dry and wet kilns, municipal waste combustors), and
e. Ultra-low NOx burner and SCR (ICI boilers).

The EPA incrementally included additional details in these summaries, including:

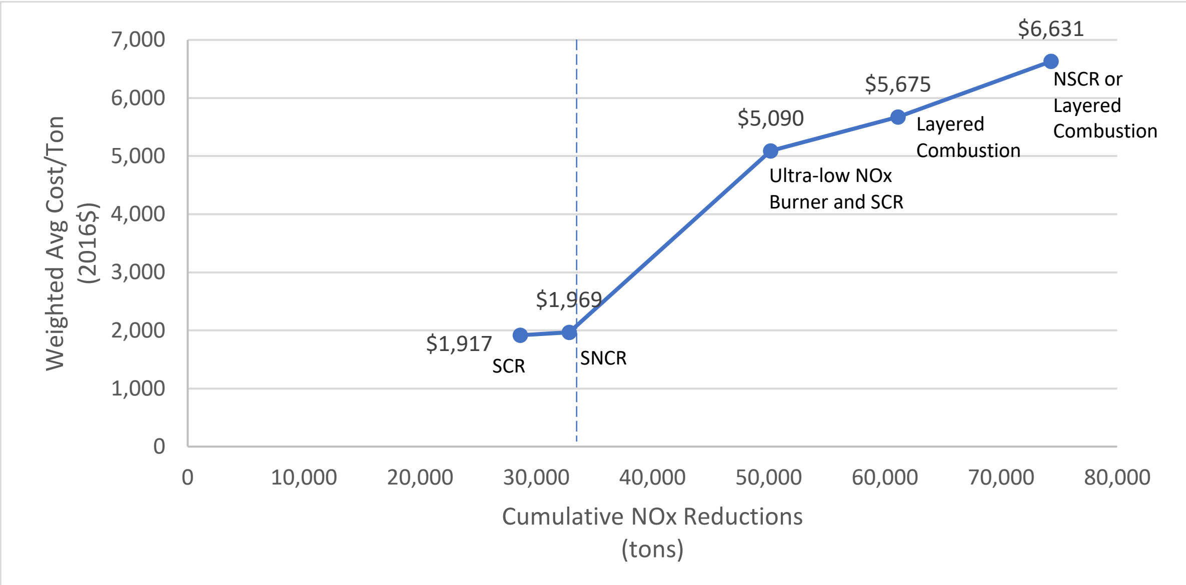
a. Emissions source group (ICI boilers, IC engines, cement kilns, glass furnaces),
b. State, and
c. Industry sector (cement/glass manufacturing, paper manufacturing, pipeline transportation).

In addition, we calculated a weighted average cost per ton for each technology, plotted the weighted average costs, and observed a clear breakpoint in the curve at $2,000 per ton.[9] This identified two tranches, or buckets, of

[9] By technology, the Agency calculated a weighted average cost per ton so that some of the outlier cost per ton values did not disproportionately impact the "average" value used to plot the curve.

potential emissions reductions (see Figure 1 below).[10] The summaries discussed above and the figure below are also available in the Excel workbook titled *Control Summary - Max Reduction $10k 150 tpy cutoff 12 States Updated Modeling – No Replace – 05-18-2020*.

Figure 1. Cumulative NOx Emission Reduction Potential (annual tons) by Weighted Average Cost Per Ton (annual cost per ton) for Control Technologies in 2023



Dotted vertical line separates the two tranches.

For the technologies above, we then:

a. Within each technology, further organized by source group, and
b. Looked closer at cost per ton within these technology/source group "bins".

These summaries are available in the Excel workbook with the CoST run results titled *CoST Control Strategy - Max Reduction $10k 150 tpy cutoff 12 States Updated Modeling - No Replace - 07-23-2020.*

The first tranche of potential emissions reductions had a weighted average cost of approximately $2,000 per ton and a cost range from ~$64 per ton - ~$5,700 per ton and included the following technology/source groupings[11]:

a. SCR – glass manufacturing – container, flat & pressed, IC engines, oil-fired and natural gas (in pipeline transportation and oil & gas extraction industry sectors), and
b. SNCR – cement manufacturing – dry and wet, municipal waste combustor.

See Table 3 for details - note that the potential emissions reductions are annual tons not ozone season tons. Additional details on this first tranche, including the potential emissions reductions and number of emissions units by state are shown in Table 4. To analyze potential emissions reductions in step 3 of the 4-step framework, we determined that the potential emissions reductions in tranche 1 are potentially relatively cost-effective because

[10] This assessment assumes annual cost per ton values. To consider whether the tranches would change using ozone season cost per ton values, we divided total annual cost by ozone season tons. The technology/source groupings stay the same, and the ozone season cost per ton values are higher.

[11] For the emissions unit estimated to generate emissions reductions at $64 per ton, the emissions and cost estimates were incorrect. The 2023 projected emissions for the unit were significantly overestimated as a result of a growth factor the EPA received for these emissions from a multi-jurisdictional partner organization. Further, the equation used to estimate the cost was mis-specified in CoST, and the true cost is likely on the order of $800 per ton. Changes to these underlying factors will likely guide an updated assessment for a final rulemaking.

the $2,000 cost per ton for non-EGU emissions reductions is similar to the control stringency for EGUs represented by $1,600 per ton (see section below on *Further Verifying and Refining Estimated Non-EGU NOx Emissions Reduction Potential* for additional discussion).

Table 3. Annual NOx Emission Reduction Potential and Annual Cost Per Ton Range by Technology and Source Group for Tranche 1 in 2023

Technology	Source Group	NOx Emission Reduction Potential (ANNUAL tpy)	Annual Cost/Ton Range (2016$/ton)
SCR	Ammonia - NG-Fired Reformers	2,113	$3,300
SCR	Glass Manufacturing - Container, Flat & Pressed*	15,570	$64 - $4,200
SCR	IC Engines - Natural Gas, Oil	8,843	$1,200 - $5,700
SCR	Iron & Steel - In-Process Combustion - Bituminous Coal	154	$4,200
SNCR	Cement Manufacturing - Dry and Wet	3,711	$1,300 - $2,000
SNCR	Municipal Waste Combustors	145	$1,900
	Total	**30,537**	
*Installing controls on glass furnaces typically involves a major update or retrofit every 8-10 years.			
This cycle could impact the potential emissions reduction estimates and costs.			

Table 4. Annual NOx Emission Reduction Potential by Technology, State, and Source Group for Tranche 1 in 2023

	State	Number of Units	NOx Emission Reduction Potential (ANNUAL tpy)
Technology		*Source Group*	
		Ammonia - NG-Fired Reformers	
SCR	Louisiana	5	2,113
		Glass Manufacturing - Container, Flat & Pressed	
SCR	Illinois	4	1,113
SCR	Indiana	3	652
SCR	Louisiana	3	535
SCR	New York	3	1,162
SCR	Ohio	3	973
SCR	Pennsylvania	6	10,804
SCR	Virginia	2	331
		IC Engines - Natural Gas, Oil	
SCR	Illinois	1	274
SCR	Indiana	5	2,024
SCR	Louisiana	7	3,860
SCR	Michigan	5	1,514
SCR	Ohio	1	131
SCR	Virginia	2	1,040
		Iron & Steel - In-Process Combustion - Bituminous Coal	
SCR	Indiana	1	154
		Cement Manufacturing - Dry and Wet	
SNCR	Indiana	8	2,236
SNCR	Maryland	1	149
SNCR	Michigan	13	1,326
		Municipal Waste Combustors	
SNCR	Maryland	1	145

The second tranche of potential emissions reductions had a weighted average cost range from approximately $5,000 per ton to $6,600 per ton and a cost range from ~$1,400 per ton - ~$9,700+ per ton and primarily included the following technology/source groupings:

a. Layered Combustion – lean burn IC engines - natural gas (in pipeline transportation and oil & gas extraction industry sectors),
b. NSCR or Layered Combustion – industrial natural gas IC engines, SCCs with technology not specified (in pipeline transportation and oil & gas extraction industry sectors), and
c. Ultra-low NOx burner and SCR – ICI boilers (in paper manufacturing, petroleum and coal products manufacturing, chemical manufacturing, and primary metal manufacturing industry sectors).

See Table 5 for details - note that the potential emissions reductions are annual tons, not ozone season tons. Additional details on this second tranche, including the potential emissions reductions and number of emissions units by state are shown in Table 6. To analyze potential emissions reductions in step 3 of the 4-step framework, we made no determination as to whether the potential emissions reductions in tranche 2 are cost-effective, and we did not look further in tranche 2 because we assumed the $1,600 per ton cost threshold for reductions from EGU sources was an equivalent cost threshold for comparison. The underlying details and summary Tables 3 through 6 are available in the Excel workbook titled *CoST Control Strategy - Max Reduction $10k 150 tpy cutoff 12 States Updated Modeling - No Replace - 07-23-2020.*

Table 5. Annual NOx Emission Reduction Potential and Annual Cost Per Ton Range by Technology and Source Group for Tranche 2 in 2023

Technology	Source Group	NOx Emission Reduction Potential (ANNUAL tpy)	Annual Cost/Ton Range (2016$/ton)
Layered Combustion	Lean Burn ICE - NG	10,963	$5,500 - $6,600
NSCR or Layered Combustion	Industrial NG ICE, SCCs with technology not specified	13,176	$6,400 - $8,300
Ultra-low NOx Burner and SCR	ICI Boilers	17,341	$1,400 - $9,700*
	Total	**41,480**	
*Weighted average cost/ton is ~$5,100.			

Table 6. Annual NOx Emission Reduction Potential by Technology, State, and Source Group for Tranche 2 in 2023

	State	Number of Units	NOx Emission Reduction Potential (ANNUAL tpy)
Technology		*Source Group*	
		Lean Burn ICE - NG	
Layered Combustion	Illinois	7	1,444
Layered Combustion	Indiana	10	2,376
Layered Combustion	Kentucky	4	752
Layered Combustion	Louisiana	3	944
Layered Combustion	Michigan	2	307
Layered Combustion	New York	1	324
Layered Combustion	Ohio	8	1,521
Layered Combustion	West Virginia	14	3,294
		Industrial NG ICE, SCCs with technology not specified	
NSCR or Layered Combustion	Illinois	10	1,708
NSCR or Layered Combustion	Kentucky	1	417
NSCR or Layered Combustion	Louisiana	31	6,731
NSCR or Layered Combustion	Ohio	23	4,319
		ICI Boilers	
Ultra-low NOx Burner and SCR	Illinois	2	387
Ultra-low NOx Burner and SCR	Indiana	9	3,810
Ultra-low NOx Burner and SCR	Kentucky	3	905
Ultra-low NOx Burner and SCR	Louisiana	25	7,119
Ultra-low NOx Burner and SCR	New York	4	1,343
Ultra-low NOx Burner and SCR	Ohio	7	2,059
Ultra-low NOx Burner and SCR	Pennsylvania	3	748
Ultra-low NOx Burner and SCR	West Virginia	3	969

Background for Determining Source Size/Threshold for Non-EGU Emissions Sources

In assessments of non-EGU emission reduction potential for previous interstate transport rulemakings, we assessed units with pre-control NOx emissions $\geq$ 100 tpy, which is the major source threshold for moderate ozone nonattainment areas. For this assessment, the EPA included units with pre-control NOx emissions $\geq$ 150 tpy, which is an emissions threshold comparable to 25 MW for EGUs used in prior interstate transport rulemakings. To derive this emissions threshold, we used emissions expected from an average 25 MW EGU unit operating at a median heat rate, emission rate, and capacity factor for a coal-fired unit. A description of this derivation is below.

The CSAPR trading program is currently restricted to EGU sources greater than 25 MW electric generating capacity in the regulation. Since non-EGU sources are not all rated in electric generating capacity, we estimated an equivalent threshold for these sources on an annual NOx emissions basis. We estimated that 150 tons of NOx emissions per year is a reasonable approximation for a typical 25 MW EGU.

This estimate represents a generic 25 MW EGU and relied on assumptions of three factors: heat rate, capacity factor, and NOx emissions rate. To develop an estimate for each of these factors, we evaluated EGUs ranging from 25 MW – 30 MW, which represent the smallest EGUs currently included in the CSAPR trading program. This sample included nine units from the following six plants (ORIS codes): 50931, 2790, 50611, 50835, 57046, 2935. We excluded one outlier unit with a NOx rate that was nearly three times higher than the next highest NOx rate. We calculated the median and average heat rate and NOx rate based on the assumptions included in NEEDS v6 rev: 3-26-2020. We calculated the median and average annual capacity factor based on Air Markets Program data reported to EPA in 2019. These values are summarized below.

	Median	**Average**
Heat Rate (Btu/kWh)	12,140	12,291
NOx Rate (lbs/MMBtu)	0.18	0.23
Capacity Factor (%)	61%	61%

The estimated annual emissions from a typical 25 MW unit based on the assumptions above ranges from about 141 annual tons (median values) to 188 annual tons (average values). Given the small sample sizes, we believe the median values are more representative than average values. Therefore, we estimated that 150 tons per year is a reasonable approximation of the annual NOx emissions at a typical 25 MW EGU. Since non-EGUs sources are not universally rated in MW electric generating capacity, we believe that NOx emissions of 150 tons per year is an equivalent threshold for use in this assessment.

Air Quality Impacts from Potential Non-EGU Emissions Reductions

Tables 7 and 8 below provide estimates of the air quality impacts at the Westport, CT receptor of the potential non-EGU emissions reductions in linked upwind states. We chose the Westport site for this assessment because it is likely the only site to remain a receptor during the time period when non-EGU controls could be implemented, assuming those controls take longer than 18 months to install. The results for Westport, CT are representative of the impacts for other coastal Connecticut receptors. In Tables 7 and 8 below, the air quality data are provided for individual upwind states and by industry sector, source category, and technology for all linked upwind states combined. Tables 7 and 8 (and the tables that follow) include potential emissions reductions in units of ozone season tons for appropriate comparison to potential EGU emissions reductions.

The estimated air quality impacts of the potential non-EGU emissions reductions are based on multiplying the estimated emissions reductions by the parts per billion (ppb) per ton values for each linkage.[12] The ppb per ton values were derived from the state-by-state contribution modeling. Since the contribution modeling included emissions from all anthropogenic sources in each state, rather than just non-EGUs, the ppb per ton values used for this analysis introduce some degree of uncertainty in the results.

In addition, because the precursor emissions in the New York City portion of New York state are a large portion of the total state emissions and given the proximity of the coastal CT receptors to New York City, the contributions from the state of New York in the modeling largely reflect the contribution from emissions within New York City and adjacent areas of southern New York. As such, the ppb per ton values for New York based on the modeling are likely to overstate, by a large amount, the ppb per ton values from sources outside of New York City. In this assessment, the estimated impacts at Westport and other coastal CT receptors of the potential non-EGU emissions reductions in New York state are likely overstated because the ppb per ton values used in the calculations are dominated by the contributions from New York City, whereas the potential non-EGU emissions reductions are from emissions units in the western part of the state. Also note that there were no potential NOx

[12] We applied the calibration factor for this receptor that is used in the Air Quality Assessment Tool (AQAT) for calculating the ozone impacts of EGU emissions reductions. The AQAT is discussed and documented in the Ozone Transport Policy Analysis TSD for this proposal. Calibration factors are intended to account for the non-linear response of ozone to NOx emissions reductions.

emissions reductions from New Jersey because the projected 2023 emissions inventory did not include non-EGU point sources in New Jersey with pre-control NOx emissions greater than 150 tpy for which CoST had applicable control measures.

Table 7. Non-EGU Emissions in 2023 and PPB Reductions at Westport, Connecticut for Individual Linked Upwind States

Linked States	OS NOx Reductions	PPB Reduction
Pennsylvania	4,813	0.144
New York	1,179	0.107
Ohio	3,751	0.048
Indiana	4,981	0.037
West Virginia	2,117	0.029
Michigan	1,311	0.013
Illinois	2,053	0.008
Kentucky	864	0.007
Virginia	571	0.006
Maryland	123	0.003
Total	***21,764***	***0.401***

Table 8. Non-EGU Emissions in 2023 and PPB Reductions at Westport, Connecticut by Industry Sector or Source Category, Technology, and Weighted Average Cost Per Ton from Linked Upwind States[13]

	Sector: Technology	OS NOx Reductions	PPB Reduction
Approx. $2,000/ton	Glass Manufacturing: SCR	5,780	0.189
	Lean Burn IC Engs: SCR	2,710	0.025
	Iron & Steel: SCR	64	0.000
	Cement: SNCR	1,546	0.014
	MWC: SNCR	61	0.001
	SubTotal	***10,161***	***0.230***
Approx. $5,000 to $6,600/ton	Lean Burn IC Eng: L Comb	4,040	0.052
	Industrial Natural Gas: NSCR/L Comb	2,685	0.027
	ICI Boilers: Ultra-low NOx Burner/SCR	3,700	0.092
	SubTotal	***10,425***	***0.172***
	Total	***20,586***	***0.401***

<u>Further Verifying and Refining Estimated Non-EGU NOx Emissions Reduction Potential</u>

Because information for existing controls on non-EGU emissions sources is missing in the 2016 base year inventory for some states and incomplete for some sources, the EPA went through a process to further verify

[13] After the initial assessment of non-EGU reduction potential, we further reviewed information related to applying SCR to IC engines (discussed below). CoST estimated the control cost inappropriately, as it applied a cost equation to a source much larger than the predictive range of the equation. In such cases, CoST should apply a cost per ton value, which would be above the $2,000 per ton threshold for cost-effectiveness. As a result, we removed these units from further consideration.

existing control information and refine the NOx emission reduction potential estimated by CoST, the CMDb, and the 2023 projected inventory in Tables 3 through 6 above. The steps the EPA took, discussed in more detail below, include:

- Considered the air quality impacts by state and focused on upwind states with the largest estimated potential air quality impacts from potential non-EGU emission reductions;
- Assumed that the potential reductions in tranche 1 were potentially cost-effective because tranche 1's weighted average cost of $2,000 per ton is similar to the control stringency for EGUs represented by $1,600 per ton;
- Looked at potential emissions reductions in tranche 1 that were estimated to cost less than $2,000 per ton; and
- For those potential reductions in tranche 1 that were estimated to cost less than $2,000 per ton, reviewed online facility permits and industrial trade literature to verify and determine if the estimated emissions reductions may be actual, achievable emissions reductions.

First, we considered the potential ppb impacts by state in Table 7 and prioritized the verification and refinement of the NOx emission reduction potential for a subset of the states with the largest estimated potential air quality impacts. We reviewed potential controls and estimated emissions reductions in Pennsylvania, New York, Ohio, Indiana, and West Virginia. The EPA identified these states using an estimate of 0.02 ppb as a threshold for air quality improvement that may be obtained from reductions from non-EGUs in each state. The Agency is not applying a 0.02 ppb impact threshold as a step in the Step 3 multi-factor test. Rather, this threshold value allowed the Agency to better target its efforts toward the potentially effective states for non-EGU NOx emissions reductions.

Next, to continue analyzing potential emissions reductions in step 3 of the 4-step framework, we determined that the potential reductions in tranche 1 (Table 3 above) were potentially relatively cost-effective because the $2,000 cost per ton cost for reductions from non-EGU sources is similar to the control stringency for EGUs represented by $1,600 per ton. While we made no determination as to whether the potential emissions reductions in tranche 2 were cost-effective, we did not look further in tranche 2 (Table 5 above) because we assumed the $1,600 per ton control stringency for proposed reductions from EGU sources was an equivalent cost threshold for comparison.[14] Note that the emissions reductions from tranche 1[15] are in the section of Table 8 with the weighted average cost of $2,000 per ton (2016$), and the emissions reductions from tranche 2 are in the section with the weighted average cost range of $5,000 to $6,600 per ton. Tranche 1 includes:

1. SCR:
   a. glass manufacturing – container, flat & pressed,
   b. IC engines – natural gas, oil (in pipeline transportation and oil & gas extraction industry sectors), and
2. SNCR:
   a. cement manufacturing – dry and wet kilns,
   b. municipal waste combustors.

The total estimated potential emissions reductions from non-EGU sources in Pennsylvania, New York, Ohio, and Indiana in tranche 1 were 7,556 ozone season tons. *Note that West Virginia dropped out because as indicated below CoST estimated control costs for two IC engines inappropriately, and CoST did not apply cost-effective*

[14] Details on these tranches can be found in the *Summary SCR and SNCR* and *Summary Other Technologies* worksheets in the *CoST Control Strategy - Max Reduction $10k 150 tpy cutoff 12 States Updated Modeling - No Replace - 07-23-2020* Excel workbook.

[15] In tranche 1 the cost per ton ranges from ~$64 per ton - ~$5,700 per ton.

controls to any other emissions units in the state. Below we note exceptions where in tranche 1 CoST applied *cost-effective* controls that were not included in the results.

- CoST applied controls to two IC engines in West Virginia for additional potential emissions reductions of 341 ozone season tons (in tranche 1 CoST did not apply controls to any other emissions units in the state). However, CoST estimated the control cost inappropriately, as it applied a cost equation to a source much larger than the predictive range of the equation. In such cases, CoST should apply a cost per ton value, which in this instance would be above the $2,000 per ton threshold for cost-effectiveness. As a result, it was determined that there are no actual controls available at the selected level of cost-effectiveness for these units. We reviewed the permits for these units -- the permit indicates that the units currently do not have control devices installed but do require periodic tune-ups and performance tests.
- CoST applied a control to an IC engine in Indiana for additional potential emissions reductions of 292 ozone season tons. Like the West Virginia controls, the cost of this control was underestimated for a source of this size, and the cost per ton for this source is above the threshold for cost-effectiveness. We reviewed the permit for this unit -- the permit indicates that the unit currently does not have a control device installed but does require performance tests and a preventive maintenance plan.

Next, we looked at the potential emissions reductions in tranche 1 that were estimated to cost ≤$2,000 per ton, which were 6,346 ozone season tons, or 84 percent of the estimated reductions in tranche 1 in these states; the remaining 16 percent of estimated reductions, or 1,210 ozone season tons, was above the $2,000 per ton threshold.

The steps taken to verify and refine the NOx emission reduction potential information were based first on technology application and related costs (as detailed above in the section on *Model and Methodology for Assessing Non-EGU Emission Reduction Potential*), then on a representative sample of states, and then on *likely cost-effective reductions* (i.e., reductions ≤ $2,000 per ton) in those states, which led to key industry sectors; we did not directly select key industry sectors to review for applicability. In the review of the potential controls in tranche 1 for Pennsylvania, New York, Ohio, and Indiana, we concluded that the likely cost-effective emissions reductions were from SCR applied to glass furnaces and SNCR applied to cement kilns.[16] Please see the additional discussion on these estimated emissions reductions in the section below titled *Conclusions on Verification and Review of Controls on Non-EGU Sources in Four States and Potential Emissions Reductions*.

We did not review the potential controls for emissions sources in tranche 1 for the remaining five states in Table 7. Based on the additional verification and review we conducted for potential controls on emissions sources in Pennsylvania, New York, Ohio, Indiana, and West Virginia (summarized in the section below titled *Detailed Verification and Review of Controls on Non-EGU Sources in Four States*), however, we believe it is reasonable to conclude that a similarly small quantity of additional NOx emissions reductions could be identified. For the remainder of the analysis, to be conservative, we assume that the tranche 1 reductions identified by CoST at or less than $2,000 per ton in these five states are real emissions reductions.[17]

Detailed Verification and Review of Controls on Non-EGU Sources in Four States

After determining it was appropriate to verify the potential emissions reductions that were estimated to cost ≤$2,000 per ton, we took the additional step of verifying and refining the information on potential controls for

[16] Note that for non-EGUs not all industry sectors are present in each of the 12 states.

[17] As discussed in more detail in the *Conclusions of Verification and Review of Controls on Non-EGU Sources in Four States and Potential Emissions Reductions* section, the possible emissions reductions from Pennsylvania, New York, Ohio, Indiana, and West Virginia were approximately 903 ozone season tons. The assumed emissions reductions from the remaining five states would be approximately 664 ozone season tons.

emissions sources in tranche 1 for Pennsylvania, New York, Ohio, and Indiana. *Note that West Virginia dropped out because CoST estimated control costs for two IC engines inappropriately, and CoST did not apply likely cost-effective controls to any other emissions units in the state.* To verify and refine the information, we reviewed facilities' online Title V permits for likely cost-effective emissions reductions associated with SCR applied to glass furnaces and SNCR applied to cement kilns, and also reviewed industrial trade literature for these facilities and their parent companies. These permit and industrial trade literature reviews were completed as of July 31, 2020.

By state, in Tables 9 through 12 below, we include information on 20 emissions units at glass manufacturing and cement manufacturing facilities including the facility name, NEI Unit ID, type of emissions unit, existing NOx control, NOx monitoring device, type of fuel used, and related notes. Of the 20 emissions units, 10 units either (i) have controls and monitors (primarily CEMS) already, (ii) are installing controls and CEMS or consolidating operations in the next few years as a result of recent consent decrees issued as part of the EPA's New Source Review Air Enforcement Initiative, (iii) have shut down, or (iv) are planning to shut down by 2023. Based on information collected through the permit review, we believe the units in categories (i) and (iii) don't present an opportunity to generate emissions reductions as part of this analysis and should be removed from further consideration. With respect to categories (ii) and (iv), for purposes of a focused analysis of potential cost-effective non-EGU emissions reductions, we excluded these units from further consideration.

Reviewing online facility permits does not always resolve outstanding questions. Permits can be 100 pages or more in length with detailed information about a facility and the units at the facility, and the accuracy and extent of information can vary by state. Matching NEI information to information in the permit is not always straight forward. For example, the NEI Unit IDs don't always match the unit ID information in the permit and even more research or refinement is needed.

Table 9. Pennsylvania Glass Manufacturing Facilities

Facility Name/NEI Unit ID[18]	Ultimate Parent Company	Type of Emissions Unit	County	2023 Projected NOx Emissions	Estimated Reductions (OS Tons) from SCR	Existing NOx Control	NOx Monitoring Device/ Technique	Fuel Used by Furnace	Other Notes	Status of Estimated Reductions[19]
Ardagh Glass Inc/Port Allegany Plt (NEI Unit ID 19110913)	Ardagh Group S.A.	Container Glass: Melting Furnace	McKean	152	47.43	LNB + OEAS	CEMS	Natural Gas	194.73 tons annual emissions limit	Remove from consideration *(Already controlled)*
Vitro Flat Glass LLC/Carlisle (NEI Unit ID 18725313)[20]	Vitro, Inc.	Flat Glass: Melting Furnace	Cumberland	10,514	3,285.65	No Control	CEMS	Natural Gas/Oil #2 (permitted for both fuels; natural gas is the typical fuel used)	Emissions limit of 26.75 lb/ton glass produced	Uncertain – see notes below *(NEI discrepancy)*
Vitro Flat Glass LLC/Carlisle (NEI Unit ID 18725413)	Vitro, Inc.	Flat Glass: Melting Furnace	Cumberland	1,236	386.27	SCR	CEMS	Natural Gas/Oil #2 (permitted for both fuels; natural gas is the typical fuel used)	Emissions limit of 7.0 lb/ton glass produced	Remove from consideration *(Already controlled)*

[18] Pennsylvania's online permits are available at the following link: http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Air_Quality/AQ_Permit_Docs.

[19] The category indicated in italics and parentheses is associated with the categories in Table 13 below.

[20] The cost per ton and potential emissions reductions for this emissions unit reflect a high degree of uncertainty. The uncertainty comes from the following two sources: (i) discrepancies between the underlying information for this unit in the 2023 projected inventory and other emissions data, and (ii) the equation in CoST that is used to estimate the emissions reductions and cost per ton value. In the 2023 projected inventory, the reported pre-control emissions are much larger than what appears in the PA Air Emissions Report (http://www.depgreenport.state.pa.us/powerbiproxy/powerbi/Public/DEP/AQ/PBI/Air_Emissions_Report) for this facility and significantly larger than any other glass furnace in this analysis, and the projected inventory does not show a control on any unit at this facility, even though a review of the permit indicates that one unit does have a control. Lastly, the equation used to estimate the costs is misspecified and yields artificially low cost per ton estimates for a source this large. The default cost per ton value from CoST for this source is roughly $800/ton (2016$) and is still within the range of costs in tranche 1.

Facility Name/NEI Unit ID[18]	Ultimate Parent Company	Type of Emissions Unit	County	2023 Projected NOx Emissions	Estimated Reductions (OS Tons) from SCR	Existing NOx Control	NOx Monitoring Device/ Technique	Fuel Used by Furnace	Other Notes	Status of Estimated Reductions[19]
Pittsburgh Glass Works/Meadville Works 8[21, 22] (NEI Unit ID 19025613)	Vitro, Inc.	Flat Glass: Melting Furnace	Crawford	1,739	543.49	No Control	CEMS	Natural Gas	766.5 tons annual emissions limit	Uncertain – closed a line on June 10, 2020 *(Shutdown)*
Guardian Ind Corporation/Jefferson Hills (NEI Facility ID 2989611)			Allegheny	512	159.93				Facility closed at end of 2015.[23]	Remove from consideration *(Shutdown)*
Subtotal					**4,422.77**					

[21] Vitro acquired this facility in 2017 - https://www.post-gazette.com/business/career-workplace/2020/04/13/Meadville-Vitro-glass-COVID-19-layoffs-pennsylvania/stories/202004130094.

[22] This facility shut down one of its two production lines effective June 10, 2020. The company stated that it will be too expensive to rebuild the production line.
https://www.glassmagazine.com/news/vitro-shut-down-float-line-automotive-glass
https://www.post-gazette.com/business/career-workplace/2020/04/13/Meadville-Vitro-glass-COVID-19-layoffs-pennsylvania/stories/202004130094

[23] https://www.post-gazette.com/business/pittsburgh-company-news/2015/06/24/Guardian-Industries-to-close-Jefferson-Hills-plant-more-than-100-face-layoffs-pittsburgh/stories/201506240183
https://www.wtae.com/article/guardian-industries-closing-jefferson-hills-plant-idling-114/7472247

Table 10. New York Glass Manufacturing Facilities

Facility Name/NEI Unit ID[24]	Ultimate Parent Company	Type of Emissions Unit	County	2023 Projected NOx Emissions	Estimated Reductions (OS Tons) from SCR	Existing NOx Control	NOx Monitoring Device/ Technique	Fuel Used by Furnace	Other Notes	Status of Estimated Reductions[25]
Anchor Glass Container Corp (NEI Unit ID 2854113)	Anchor Glass Container Corp	Container Glass: Melting Furnace	Chemung	450	140.63	Two furnaces – Furnace #1 – SCR; Furnace #2 – no control	CEMS	Natural Gas	Furnace #1 has an annual emissions limit of 1.2 lb NOx/ton of glass produced. Furnace #2 has an annual emissions limit of 4.5 lb NOx/ton of glass produced.	Possible *(Possible emissions reductions)*
Owens Brockway Glass Container Inc (NEI Unit ID 2863113)	O-I Glass, Inc.	Container Glass: Melting Furnace	Cayuga	309	96.69	Two furnaces – No controls indicated	CEMS	Natural Gas	Furnace A has an annual emissions limit of 4.0 lb NOx/ton of glass produced. Furnace B has an annual emissions limit of ?	Possible *(Possible emissions reductions)*

[24] New York's online permits are available at the following link: http://www.dec.ny.gov/dardata/boss/afs/issued_atv.html.
[25] The category indicated in italics and parentheses is associated with the categories in Table 13 below.

Guardian Geneva Float Glass Facility[26] (NEI Unit ID 18725413)	Koch Industries, Inc.	Flat Glass: Melting Furnace	Ontario	790	246.83	SCR	CEMS	Natural Gas	Annual emissions limit of 770 tons	Remove from consideration *(Already controlled)*
Subtotal					**484.15**					

Table 11. Ohio Glass Manufacturing Facility

Facility Name/NEI Unit ID[27]	Ultimate Parent Company	Type of Emissions Unit	County	2023 Projected NOx Emissions	Estimated Reductions (OS Tons) from SCR	Existing NOx Control	NOx Monitoring Device/ Technique	Fuel Used by Furnace	Other Notes	Status of Estimated Reductions[28]
Pilkington North America Inc. (NEI Unit ID 55204113)		Flat Glass: Melting Furnace	Wood	755	236	Two furnaces - None indicated for furnace #1; 3R technology[29] for furnace #2 (technology is proprietary)	CEMS	Natural Gas or Oil (permitted for both; natural gas the typical fuel used)	Furnace #1 has annual emissions limit of 364.7 tons – a recent stack test show emissions at the furnace are 41.64 tons NOx. Furnace #2 has an annual emissions limit of 945 tons -- CEMS data show recent emissions of 792.98 tons.	Uncertain – recent stack test shows emissions well below permit limit *(Already controlled)*
Subtotal					**236**					

[26] This facility is subject to a consent decree with the U.S. requiring that SCR be installed on its furnace to be shutdown with compliance actions to be taken between December 31, 2017 and December 31, 2024. A NOx CEMS is already in place. Consent decree is at https://elr.info/sites/default/files/doj-consent-decrees/united_states_v._guardian_industries_corp.pdf.

[27] Ohio's online permits are available at the following link: https://www.epa.ohio.gov/dapc/permits/permits.

[28] The category indicated in italics and parentheses is associated with the categories in Table 13 below.

[29] 3R is a NOx control technology that involves combustion modification using excess natural gas to create reducing conditions within a glass furnace in order to reduce NOx emissions. A BACT permit by Cardinal Glass in Portage, WI, filed with the Wisconsin Department of Natural Resources (WIDNR) (December 8, 2017) indicates that this technology may lead to long-term furnace and refractory damage based on their experience with the use of 3R at 3 other plants of theirs in the U.S. The CMDb does not include the 3R process as a NOx control technology.

Table 12. Indiana Glass Manufacturing and Cement Manufacturing Facilities

Facility Name/NEI Unit ID[30]	Ultimate Parent Company	Type of Emissions Unit	County	2023 Projected NOx Emissions	Estimated Reductions (OS Tons) from SCR and SNCR	Existing NOx Control	NOx Monitoring Device/ Technique	Fuel Used by Furnace	Other Notes	Status of Estimated Reductions[31]
Ardagh Glass Inc. (NEI Unit ID 65375713)	Ardagh Group S.A.	Container Glass: Melting Furnace	Randolph	312	97.63	No Control	No monitors	Natural Gas	Furnace #2 has an annual emissions limit of 506.9 tons. This furnace may be emitting under its permit limit.	Possible *(Possible emissions reductions)*
Ardagh Glass Inc. (NEI Unit ID 65375813)	Ardagh Group S.A.	Container Glass: Melting Furnace	Randolph	280	87.65	No Control	No monitors	Natural Gas	Furnace #1 has an annual emissions limit of 389.24 tons. This furnace may be emitting under its permit limit.	Possible *(Possible emissions reductions)*

[30] Indiana's online permits are available at the following link: https://www.in.gov/apps/idem/caats/.
[31] The category indicated in italics and parentheses is associated with the categories in Table 13 below.

Facility Name/NEI Unit ID[30]	Ultimate Parent Company	Type of Emissions Unit	County	2023 Projected NOx Emissions	Estimated Reductions (OS Tons) from SCR and SNCR	Existing NOx Control	NOx Monitoring Device/ Technique	Fuel Used by Furnace	Other Notes	Status of Estimated Reductions[31]
Anchor Glass Container Corporation (NEI Unit ID 28314513)	Anchor Glass Container Corp.	Container Glass: Melting Furnace	Dearborn	276	86.28	No control	No monitors	Natural Gas	Facility-wide annual emissions limit of 396 tons, which likely includes additional emissions sources.	Possible *(Possible emissions reductions)*
Lehigh Cement Company (NEI Unit ID 5813813)	Heidelberg Cement	Long Kiln	Clark	187	38.89	SNCR	CEMS	Natural Gas (coal or oil as backup fuels)	NOx control & monitoring required under consent decree (Essroc). Plant to cease operations during 2022.	Remove from consideration *(Shutdown)*
Lehigh Cement Company (NEI Unit ID 5813313)	Heidelberg Cement	Preheater Kiln	Clark	394	82.08	SNCR	CEMS	Natural Gas (coal or oil as backup fuels)	NOx control & monitoring required under consent decree (Essroc). Plant to cease operations	Remove from consideration *(Shutdown)*

Facility Name/NEI Unit ID[30]	Ultimate Parent Company	Type of Emissions Unit	County	2023 Projected NOx Emissions	Estimated Reductions (OS Tons) from SCR and SNCR	Existing NOx Control	NOx Monitoring Device/ Technique	Fuel Used by Furnace	Other Notes	Status of Estimated Reductions[31]
									during 2022.	
Lehigh Cement Company (NEI Unit ID 4232613)	Heidelberg Cement	Preheater Kiln	Lawrence	552	115.09	No control	No monitoring	Natural gas	Plant is subject to NOx requirements in consent decree; a single kiln will replace all 3 preheater kilns in 2023. Permit indicates MKF or LNB as controls for ozone season, but no evidence of installation.	Remove from consideration *(Lehigh Cement – kiln replacements)*
Lehigh Cement Company (NEI Unit ID 4232813)	Heidelberg Cement	Preheater Kiln	Lawrence	495	103.21	No control	No monitoring	Natural gas	Plant is subject to NOx requirements in consent decree; a single kiln will replace all 3	Remove from consideration *(Lehigh Cement – kiln replacements)*

Facility Name/NEI Unit ID[30]	Ultimate Parent Company	Type of Emissions Unit	County	2023 Projected NOx Emissions	Estimated Reductions (OS Tons) from SCR and SNCR	Existing NOx Control	NOx Monitoring Device/ Technique	Fuel Used by Furnace	Other Notes	Status of Estimated Reductions[31]
									preheater kilns in 2023. Permit indicates MKF or LNB as controls for ozone season, but no evidence of installation.	
Lehigh Cement Company (NEI Unit ID 4233913)	Heidelberg Cement	Preheater Kiln	Lawrence	711	148.10	No control	No monitoring	Natural gas	Plant is subject to NOx requirements in consent decree; a single kiln will replace all 3 kilns by 2023. Plant is subject to NOx control by MKF or LNB in ozone season, but no evidence of installation.	Remove from consideration *(Lehigh Cement – kiln replacements)*

Facility Name/NEI Unit ID[30]	Ultimate Parent Company	Type of Emissions Unit	County	2023 Projected NOx Emissions	Estimated Reductions (OS Tons) from SCR and SNCR	Existing NOx Control	NOx Monitoring Device/ Technique	Fuel Used by Furnace	Other Notes	Status of Estimated Reductions[31]
Lehigh Cement Company (NEI Unit ID 65392513)	Heidelberg Cement	Wet Kiln	Cass	314	65.49	WI (water injection)	CEMS	Coal or oil	Kiln #2 has an emissions limit of 4.75 lb NOx/ton clinker produced	Possible *(Possible emissions reductions)*
Lehigh Cement Company (NEI Unit ID 65392613)	Heidelberg Cement	Wet Kiln	Cass	242	50.33	SNCR + WI	CEMS	Coal or oil	Kiln #1 does not have an emissions limit indicated in the permit	Remove from Consideration *(Already controlled)*
Lone Star Industries Inc. (NEI Unit ID 9180513)	Buzzi Unicem	Semi-Dry Kiln	Putnam	1,578	328.66	Low NOx calciner + good combustion practice (GCP)	CEMS	Coal or Oil	Kiln has an emissions limit of 5.514 lb NOx/ton of clinker produced	Possible *(Possible emissions reductions)*
Subtotal					**1,203.41**					

Conclusions of Verification and Review of Controls on Non-EGU Sources in Four States and Potential Emissions Reductions

CoST identified cost-effective (i.e., $2,000 per ton or less) control technologies for 20 emissions units at glass manufacturing and cement manufacturing facilities in Pennsylvania, New York, Ohio, and Indiana. None of these units are owned by small businesses as defined by the Small Business Administration's (SBA) small business size standards for these two industry sectors.[32] The total potential emissions reductions in Pennsylvania, New York, Ohio, and Indiana in tranche 1 were 7,556 ozone season tons. We looked at potential emissions reductions in tranche 1 that were estimated to cost ≤$2,000 per ton (*likely cost-effective*), which were 6,346 ozone season tons. We reviewed online permits for these 20 units and as indicated in Tables 9 through 12, 10 of these units either (i) have controls and monitors (primarily CEMS) already, (ii) are installing controls and CEMS or consolidating operations in the next few years as a result of recent consent decrees issued as part of the EPA's New Source Review Air Enforcement Initiative, (iii) have shutdown, or (iv) are planning to shut down by 2023.[33] Table 13 below summarizes the status of the potential emissions reductions.

Table 13. Status of Estimated Emissions Reductions

	# of Emissions Units	**OS Tons**	**(% of Total)**
Shutdowns	4	824	13
Lehigh Cement - Kiln Replacements	3	366	6
NEI Discrepancy/Uncertain	1	3,286	51
Already Controlled/Uncertain	5	967	15
Possible Emissions Reductions	7	903	14
TOTAL	**20**	**6,346**	

Based on the 2023 projected inventory, the emissions reductions from the plant shutdowns and consolidated operations (between 2015 and 2023) are estimated to be approximately 824 tons, or ***13 percent of the potentially cost-effective ozone season emissions reductions in tranche 1. These emissions reductions are not currently reflected in the estimated air quality impacts shown above in Tables 7 and 8.*** In addition, for the Lehigh Cement manufacturing facility in Lawrence County, Indiana (emissions reductions estimated to be 366.40 tons, or 6 percent of the potentially cost-effective ozone season emissions reductions in tranche 1) that is subject to a consent decree, the 2023 projected inventory emissions are 1,758 tons and we currently do not know what the expected emissions reductions may be. We have found that the three older kilns currently in operation will shut down by 2023 and be replaced with a single new kiln whose production capacity will be almost 3 times as large (2.8 million tons of clinker compared to 1 million tons of clinker currently) and whose NOx emissions are unknown.

Ten facilities, summarized again below in Table 14, were estimated to have the potential to generate some emissions reductions. However, results from the review of online permit review and industrial trade literature suggest that some of those potential reductions may not be true potential reductions. The status of the potential reductions at the ten facilities is summarized below, along with an assessment of the likelihood that

[32] U.S. Small Business Administration (SBA). Table of Small Business Size Standards as of August 19, 2019. Available at https://www.sba.gov/sites/default/files/2019-08/SBA%20Table%20of%20Size%20Standards_Effective%20Aug%2019%2C%202019_Rev.pdf.

[33] The status of three of these 10 facilities reflects some uncertainty. Those facilities include Vitro Flat Glass LLC/Carlisle, PA, Pittsburgh Glass Works/Meadville Works 8, PA, and Pilkington North America Inc., OH. The uncertainty associated with the potential emissions reductions from these three facilities is discussed in this section.

recommended controls could generate any emissions reductions. The assessment for each facility concludes with either "uncertain" or "possible" depending on the likelihood of potential emissions reductions.

- Vitro Flat Glass LLC/Carlisle, PA (NEI Unit ID 18725313), 3,285.65 OS tons – The cost per ton and estimated emissions reductions for this emissions unit reflect a high degree of uncertainty. The uncertainty comes from the following two sources: (i) discrepancies between the underlying information for this unit in the 2023 projected inventory and other more recent emissions data, and (ii) the equation in CoST that is used to estimate the emissions reductions and cost per ton value. In the projected inventory, the pre-control 2023 emissions for one of the emissions units (10,514 tons) are much larger than what appears in the 2018 PA Air Emissions Report for the entire facility (1,770 tons) and six times larger than any other glass furnace in this analysis.[34] ***The discrepancies in emissions (roughly 8,700 tons) and estimated emissions reductions (3,285.65 ozone season tons, or 51 percent of the likely cost-effective ozone season emissions reductions in tranche 1) are not currently reflected in the estimated air quality impacts shown above in Tables 7 and 8.*** In addition, the projected inventory does not show a control on any unit at this facility, even though a review of the permit indicates that one unit does have a control.
Emission Reduction Potential: Uncertain, NEI discrepancy

- Pittsburgh Glass Works/Meadville Works 8, PA (NEI Unit ID 19025613), 543.49 OS tons -- This facility shut down one of its two production lines effective June 10, 2020. The company stated that it is too expensive to rebuild the production line.
Emission Reduction Potential: Uncertain, potentially shutdown

- Anchor Glass Container Corp, NY (NEI Unit ID 2854113), 140.63 OS tons -- Furnace #2 has an annual emissions limit of 4.5 lb NOx/ton of glass produced and no current control.
Emission Reduction Potential: Possible

- Owens Brockway Glass Container Inc., NY (NEI Unit ID 2863113), 96.69 OS tons – The permit shows two furnaces with no controls.
Emission Reduction Potential: Possible

- Pilkington North America Inc., OH (NEI Unit ID 55204113), 236 OS tons – In the permit, Furnace #1 was listed with an annual emissions limit of 364.7 tons, but a recent stack test indicates emissions at the furnace are 41.64 tons of NOx.
Emission Reduction Potential: Uncertain, potentially already controlled

- Ardagh Glass Inc., IN (NEI Unit ID 65375713), 97.63 OS tons – In the permit, Furnace #2 has an annual emissions limit of 506.9 tons and the 2023 projected emissions are 312 tons. It is possible the source is currently operating under its permit limit.
Emission Reduction Potential: Possible

- Ardagh Glass Inc., IN (NEI Unit ID 65375813), 87.65 OS tons – In the permit, Furnace #1 has an annual emissions limit of 389.24 tons and the 2023 projected emissions are 280 tons. It is possible the source is currently operating under its permit limit.
Emission Reduction Potential: Possible

- Anchor Glass Container Corporation, IN (NEI Unit ID 28314513), 86.28 OS tons – Facility-wide annual emissions limit of 396 tons, which likely includes additional emissions sources.

[34] In the 2017 NEI, the NOx emissions for the larger furnace are approximately 2,076 tons.

Emission Reduction Potential: Possible

- Lehigh Cement Company, IN (NEI Unit ID 65392513), 65.49 OS tons – Currently uses water injection as control technology.
  Emission Reduction Potential: Possible

- Lone Star Industries Inc., IN (NEI Unit ID 9180513), 328.66 OS tons – Currently uses low NOx calciner + good combustion practice (GCP) as control technology.
  Emission Reduction Potential: Possible

Table 14. Potential Emissions Reductions from Glass Manufacturing Facilities in Pennsylvania, New York, Ohio, and Indiana

Facility Name/NEI Unit ID	Type of Emissions Unit	County (State)	2023 Projected NOx Emissions	Estimated Reductions (OS Tons)	Existing NOx Control	NOx Monitoring Device/ Technique	Status of Estimated Reductions
Vitro Flat Glass LLC/Carlisle (NEI Unit ID 18725313)	Flat Glass: Melting Furnace	Cumberland (PA)	10,514	3,285.65	No Control	CEMS	Uncertain, NEI discrepancy
Pittsburgh Glass Works/Meadville Works 8 (NEI Unit ID 19025613)	Flat Glass: Melting Furnace	Crawford (PA)	1,739	543.49	No Control	CEMS	Uncertain, potentially shutdown
Anchor Glass Container Corp (NEI Unit ID 2854113)	Container Glass: Melting Furnace	Chemung (NY)	450	140.63	Two furnaces – Furnace #1 – SCR; Furnace #2 – no control	CEMS	Possible
Owens Brockway Glass Container Inc (NEI Unit ID 2863113)	Container Glass: Melting Furnace	Cayuga (NY)	309	96.69	Two furnaces – No controls indicated	CEMS	Possible
Pilkington North America Inc. (NEI Unit ID 55204113)	Flat Glass: Melting Furnace	Wood (OH)	755	236	Two furnaces - None indicated for furnace #1; 3R technology for furnace #2 (technology is proprietary)	CEMS	Uncertain, potentially already controlled
Ardagh Glass Inc. (NEI Unit ID 65375713)	Container Glass: Melting Furnace	Randolph (IN)	312	97.63	No Control	No monitors	Possible
Ardagh Glass Inc. (NEI Unit ID 65375813)	Container Glass: Melting Furnace	Randolph (IN)	280	87.65	No Control	No monitors	Possible
Anchor Glass Container Corporation (NEI Unit ID 28314513)	Container Glass: Melting Furnace	Dearborn (IN)	276	86.28	No control	No monitors	Possible
Lehigh Cement Company (NEI Unit ID 65392513)	Wet Kiln	Cass (IN)	314	65.49	WI (water injection)	CEMS	Possible
Lone Star Industries Inc. (NEI Unit ID 9180513)	Semi-Dry Kiln	Putnam (IN)	1,578	328.66	Low NOx calciner + good combustion practice (GCP)	CEMS	Possible

In summary, the total potential emissions reductions in Pennsylvania, New York, Ohio, and Indiana in tranche 1 were 7,556 ozone season tons. We looked at potential emissions reductions in tranche 1 that were estimated to cost <u><</u>$2,000 per ton, which were 6,346 ozone season tons. ***Between unit shutdowns and potentially incorrect emissions data in the 2023 projected inventory (and a resulting incorrect estimate of potential emissions reductions), of the 6,346 tons approximately 4,110 tons, or 64 percent, of the likely cost-effective emissions reductions are not or may not be true emissions reductions. The potential emissions reductions associated with applying CoST-recommended controls that are considered possible are 903 ozone season tons, or 14 percent of the likely cost-effective emissions reductions.***

Caveats and Limitations of the Cost Analysis

The EPA acknowledges several important caveats and limitations of the non-EGU cost assessment included in this memorandum, which include the following:

Boundary of the cost analysis: In this cost analysis we include only the impacts to the sectors and facilities that are the focus of this analysis. We include the costs for purchase, installation, operation, and maintenance of control equipment over the lifetime of the equipment. Recordkeeping, reporting, testing and monitoring costs are not included.[35] Additional revenue may be generated by vendors that would build, install, and test new control technologies for use at sources in the directly affected sectors, especially for control equipment manufacturers, distributors, or service providers. These revenue and employment impacts are not included in this cost analysis.

Cost and effectiveness of control technologies: The application of control technologies reflect average retrofit factors nationally and equipment life. We do not account for regional or local variation in capital and annual cost items such as energy, labor, and materials. The estimates of control technology costs may over- or under-estimate the costs depending on how the difficulty of actual retrofitting and equipment life compares with the control and cost assumptions. In addition, the estimates of control efficiencies for control technologies included in the assessment assume that the control devices are properly installed and maintained.

Interest rate: We apply an interest rate of 7 percent to annualize capital costs in the analysis. In addition, while this interest rate is consistent with guidance as found in the EPA Air Pollution Control Cost Manual,[36] (hereafter called the “Control Cost Manual”) the actual interest rate may vary for control cost estimation at each facility included in this analysis.

Accuracy of control costs: We estimate that there is an accuracy range of +/- 30 percent for non-EGU point source control cost estimates. This level of accuracy is described in the Control Cost Manual, which is a basis for the estimation of non-EGU control cost estimates included in this memorandum. This level of accuracy is consistent with either the budget or bid/tender level of cost estimation (or Class 4) as defined by the American Association for Cost Engineering (AACE) International and explained in Section 1, Chapter 2 of the Control Cost Manual. In addition, the accuracy of costs is also influenced by the availability and extent of data underlying the cost estimates for individual control technologies.

[35] Many of the sources included in this cost analysis already have NOx monitors (primarily CEMS) installed, as shown in Tables 9-14, which partially offsets this limitation.
[36] U.S. EPA, Office of Air Quality Planning and Standards. EPA Air Pollution Control Cost Manual. Section 1, Chapter 2, pp. 15-17. Available on the Internet at https://www.epa.gov/sites/production/files/2017-12/documents/epaccmcostestimationmethodchapter_7thedition_2017.pdf.

Control Installation Timing

We previously examined the time necessary to install the controls listed above for different industries. The 2016 *Final Technical Support Document (TSD) for the Final Cross-State Air Pollution Rule for the 2008 Ozone NAAQS, Assessment of Non-EGU NOx Emission Controls, Cost of Controls, and Time for Compliance Final TSD* (CSAPR Update non-EGU TSD) provided preliminary estimates of installation times for a variety of NOx control technologies applied to a large number of sources in non-EGU industry sectors.[37] For virtually all NOx controls applied to cement manufacturing and glass manufacturing information on installation times was not available to provide an estimate, and we concluded that the installation time for these controls was "uncertain." There was an exception for SNCR applied to cement kilns, and the installation time estimate of 42-51 weeks listed in the CSAPR Update non-EGU TSD does not account for implementation across multiple sources, the need to have NOx monitors installed, and other steps in the permitting and construction processes.

To improve upon information from the CSAPR Update Non-EGU TSD on installation times for SCR on glass furnaces and SNCR on cement kilns, EPA reviewed information from permitting actions and a consent decree. For two glass manufacturing facilities that installed SCR on glass furnaces, from the time of permit application to the time of SCR operation was approximately 19 months for one facility and is currently at least 20 months for another facility.[38] These installation times do not reflect time needed for pre-construction design and engineering, financing, and factors associated with scaling up construction services for multiple installations at several emissions units. With respect to cement kilns, an April 2013 consent decree between EPA and CEMEX, Inc. required installation of SNCR at a kiln within 450 days, or approximately 15 months, of the effective date of the consent decree.[39] Similarly, this installation time does not reflect time associated with scaling up construction services for multiple control installations at several emissions units.

Request for Comment and Additional Information

To develop a more complete record the EPA requests comment on several questions related to specific control strategies the Agency evaluated, and in particular seeks feedback and data from stakeholders with relevant expertise or knowledge. Should such additional information and analyses show that emissions reductions from non-EGU sources in the linked upwind states would be more cost-effective than what is included in the EPA's current assessment, available for installation earlier than the EPA estimates, or more impactful on downwind air quality than the EPA's current information suggests, then the Agency remains open to the possibility of finalizing a rule requiring such controls as may be justified under the Step 3 multi-factor test.

As indicated above, information about existing controls on non-EGU emissions sources in the inventory was missing for some states and incomplete for some sources. The approach the EPA used in this proposal was to assess emission reduction potential using CoST and the projected 2023 inventory to identify emissions units that were uncontrolled. Given that the EPA's assessment of any other NOx control strategies would also rely on CoST, the CMDb, and the inventory to identify emissions units that were uncontrolled and to assess emission reduction potential from non-EGU sources, the Agency believes such an assessment would likely lead to a similar conclusion that estimated emission reduction potential is uncertain.

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[37] The CSAPR Update non-EGU TSD is available on the EPA's website at the following link: https://www.epa.gov/airmarkets/assessment-non-egu-nox-emission-controls-cost-controls-and-time-compliance-final-tsd.

[38] Cardinal FG Company submitted a permit application to the Wisconsin Department of Natural Resources (WIDNR) to construct an SCR in December 2017 at a facility in Portage, Wisconsin. The SCR was expected to be ready for testing in mid-July 2019. In addition, Cardinal FG Company submitted a permit application to the WIDNR to construct an SCR in January 2019 at a facility in Menomonie, Wisconsin. The SCR is currently not operational.

[39] The consent decree can be located at the following link: https://www.epa.gov/sites/production/files/documents/cemex-lyons-cd.pdf.

As such, for this and future regulatory efforts, to improve the underlying data used in an assessment of emission reduction potential from non-EGU sources, we request comments on: (i) the existing assessment of emission reduction potential from glass furnaces and cement kilns; (ii) emission reduction potential from other control strategies or measures on a variety of emissions sources in several industry sectors; and (iii) the feasibility of further controlling NOx from IC engines and large ICI boilers, including optimizing combustion and installing ultra-low NOx burners. The three sections below introduce the areas for comment and describe workbooks generated by CoST, the CMDb, and the 2023 projected inventory with the underlying data to review for comment.

First, the EPA requests comment on the aspects of the assessment presented above of emission reduction potential from the glass and cement manufacturing sectors. To help inform review and comments, please see the following Excel workbooks available in the docket: (i) for a summary of the CoST run results *CoST Control Strategy - Max Reduction $10k 150 tpy cutoff 12 States Updated Modeling - No Replace - 07-23-2020,* and (ii) for summaries of emissions reductions by control technologies, *Control Summary - Max Reduction $10k 150 tpy cutoff 12 States Updated Modeling – No Replace – 05-18-2020*. Note that the *CoST Control Strategy - Max Reduction $10k 150 tpy cutoff 12 States Updated Modeling - No Replace - 07-23-2020* Excel workbook includes a READ ME worksheet that provides details on the parameters used for the CoST run.

Specifically, the EPA is soliciting comment on the following:

- Are applying SCR to uncontrolled or under-controlled glass furnaces and SNCR to uncontrolled or under-controlled cement kilns in the linked states feasible approaches to achieve cost-effective emissions reductions? If not, what types of cost-effective controls can be applied to these sources?
- Does the EPA have the right and most up to date information on emissions and existing control technologies for the units included in this assessment? If not, what is the correct and more up to date information?
- After looking at the underlying CoST run results, are the cost estimates accurate and reasonable? If not, what are more accurate cost estimates?
- What is the earliest possible installation time for SCR on glass furnaces?
- What is the earliest possible installation time for SNCR on cement kilns?
- For the non-EGU facilities without any emissions monitors, what would CEMS cost to install and operate? How long would CEMS take to program and install?

In addition to the assessment of emission reduction potential from the glass and cement manufacturing sectors, for the 12 linked states the EPA attempted to summarize all potential control measures for emissions units with 150 tpy or more pre-control NOx emissions in 2023 in several industry sectors. This information illustrates that there are many potential approaches to assessing emissions reductions from non-EGU emissions sources or units. We used the Least Cost Control Measure worksheet from a CoST run.[40] By state for the 12 linked states and then by facility, this information is summarized in the Excel workbook titled *CoST Control Possibilities $10k 150 tpy cutoff 12 States Updated Modeling - 06-30-2020,* also available in the docket.

Second, specifically the EPA requests comment on the following:

- Other than glass and cement manufacturing, are there other sectors or sources that could achieve potentially cost-effective emissions reductions? What are those sectors or sources? What control technologies achieve the reductions? What are cost estimates and installation times for those control technologies?
- Are there other sectors where cost effective emission reductions could be obtained by, in lieu of installing

[40] The Least Cost Control Measure worksheet is a table of all possible emissions source-control measure pairings (for sources and measures that meet the respective criteria specified for a control strategy), each of which contains information about the cost and emissions reductions achieved if the control measure were to be applied to the emissions source.

controls, replacing older, higher emitting equipment with newer equipment?

- Are there sectors or sources where cost effective emission reductions could be obtained by switching from coal-fired units to natural gas-fired units?
- For non-EGU sources without emissions monitors, what would CEMS cost to install and operate? How long would CEMS take to program and install? Are monitoring techniques other than CEMS, such as predictive emissions monitoring systems (PEMS), sufficient for certain non-EGU facilities that would not be brought into a trading program? If so, for what types of non-EGU facilities, and under what circumstances, would PEMS be sufficient? What would be the cost to install and operate monitoring techniques other than CEMS?

Third, in the workbook titled *CoST Control Possibilities $10k 150 tpy cutoff 12 States Updated Modeling - 06-30-2020* the EPA included two worksheets with information on controls for ICI boilers and IC engines: (i) *Boilers – ULNB* and (ii) *IC Engines - LEC*. For the 12 linked states, the EPA summarized CoST's application of ultra-low NOx burners (ULNB) on ICI boilers and low emission combustion (LEC) on IC engines. Assuming that the estimated emissions reductions from CoST's application of these controls are real and cost-effective, there could be approximately 5,000 ozone season tons of emissions reductions from 52 ICI boilers and 8,000 ozone season tons of emissions reductions from 69 IC engines. This information is summarized in Table 15 below.

Table 15. Summary of Potential Emissions Reductions from ULNB on ICI Boilers and LEC on IC Engines

	ICI Boilers	**IC Engines**
Number of Emissions Units in the 12 Linked States (≥150 tpy NOx emissions)	52	69
2023 Projected Total NOx Emissions in the 12 Linked States (ozone season tons, reflects any existing control before ULNB or LEC were applied)	6,779	9,260
2023 Projected Total NOx Emissions in the 12 Linked States after Applying ULNB to Boilers (ozone season tons)	1,695	--
2023 Projected Total NOx Emissions in the 12 Linked States after Applying LEC to IC Engines (ozone season tons)	--	1,231
Number of Units with No Known Existing Control	51	57

The EPA is requesting comments on the feasibility of further controlling NOx from IC engines and large ICI boilers, including optimizing combustion and installing low NOx burners. The Agency understands that it is generally possible to install low NOx burners on EGU boilers fairly quickly and that these burners can significantly reduce NOx emissions. We note that in the original interstate transport rule, the NOx SIP call, the Agency concluded that controls on large, non-EGU boilers and turbines were cost effective and allowed states to include those emissions sources in their budgets as a means of providing additional opportunities to reduce state-wide NOx emissions in a cost-effective manner.[41] Therefore, we solicit comment on whether the EPA should require that large non-EGU boilers and turbines -- as defined in the NOx SIP call as boilers and turbines with heat inputs greater than 250 mmBTU per hour or with NOx emissions greater than 1 ton per ozone season day[42] -- within the 12 states employ controls that achieve emissions reductions greater than or equal to what can be achieved through the installation of low NOx burners.

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[41] See 63 FR 57402.

[42] Note that the 250 mmBTU/hr for ICI boilers and turbines is equivalent to 25 MW heat input for an EGU. Also, the tonnage per source was 1 ton per ozone season day. Because controls on non-EGUs operate year-round, the emissions would be 365 tons per year.

Also, five of the 12 states that are subject to this rulemaking are also within the Ozone Transport Region (OTR) -- Maryland, New Jersey, New York, Pennsylvania, and Virginia. As member states of the OTR, these five states are required to implement reasonably available control technology (RACT) state-wide on major sources of emissions.[43] It is likely that NOx controls, such as low NOx burners, are already in wide-spread use within states these five states. However, such controls may not be as widely used in states outside of the OTR. Therefore, we also solicit comment on the (i) magnitude of the emissions reductions that could be achieved by requiring that large non-EGU boilers and turbines install controls that achieve emissions reductions greater than or equal to what could be achieved through the installation of low NOx burners, (ii) prevalence of these or better NOx controls already in place on this equipment in these 12 states, and (iii) time it typically takes to install such controls.

In addition to the above, the EPA is requesting comments on the following:

- How effective are ultra-low NOx burners or low NOx burners in controlling NOx emissions from ICI boilers?
- Are they generally considered part of the process or add-on controls? If they are part of a process, how could the EPA estimate the cost associated with changing the process to accommodate ultra-low NOx burners and low NOx burners?
- What are the costs (capital and annual) for these as add-on control technologies on ICI boilers?
- What are the earliest possible installation times for these control technologies on ICI boilers? The EPA believes it is generally possible to install low NOx burners on EGU boilers relatively quickly and that low NOx burners can significantly reduce NOx emissions. The EPA solicits comment on whether this is also true for large non-EGU ICI boilers.
- Do some of the emissions units included in the summary already have either add-on controls or controls that are part of a process? If so, what control is on the unit and what is the control device (or removal) efficiency?
- Natural gas compressor stations are the largest NOx-emitting non-EGU sector[44] affecting the 12 states that are the subject of this proposal, and many of these facilities are powered by decades-old, uncontrolled IC engines. Should emissions reductions be sought from the IC engines at these stations, either through installing controls, upgrading equipment, or other means?
- How effective is low emission combustion in controlling NOx from IC engines?
- What is the cost (capital and annual) for low emission combustion on IC engines?
- What is the earliest possible installation time for low emission combustion on IC engines? In lieu of installing controls, is replacing older, higher emitting equipment with newer equipment a cost-effective way to reduce emissions from IC engines?
- Do some of the emissions units included in the summary already have either add-on controls or controls that are part of a process? If so, what control is on the unit and what is the control device (or removal) efficiency?

Attachments

1. *CoST Control Strategy - Max Reduction $10k 150 tpy cutoff 12 States Updated Modeling - No Replace - 07-23-2020.xlsx*
2. *Control Summary - Max Reduction $10k 150 tpy cutoff 12 States Updated Modeling – No Replace – 05-18-2020.xlsx*

[43] One exception to the requirement of state-wide RACT within the OTR is for Virginia. Only the Northeast portion of the state is included within the OTR and only facilities within that portion of the state are subject to RACT.

[44] Based on data from the 2017 National Emissions Inventory (NEI) database. For additional details on the 2017 NEI data summaries, please see the Excel workbook titled *2017 NEI Data_Twelve States_Merged_Greater than 100 Tons* in the docket.

3. *CoST Control Possibilities $10k 150 tpy cutoff 12 States Updated Modeling - 06-30-2020.xlsx*
4. *2017 NEI Data_Twelve States_Merged_Greater than 100 Tons.xlsx*