

NERA

Economic Consulting

Estimated Economic Impacts on Tennessee of EPA 2010 Ozone Proposal

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Study Team

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Introduction and Objective

- EPA issued a reconsideration in January 2010 that would lower the primary (8-hour) ambient ozone standard to a level between 60 and 70 parts per billion (ppb).
- This study evaluates potential 2020 attainment costs and economic impacts in Tennessee from an ozone standard of 60 ppb relative to a standard of 84 ppb (EPA baseline).

Baseline 2020 Nonattainment Status and Consequences for Tennessee Counties

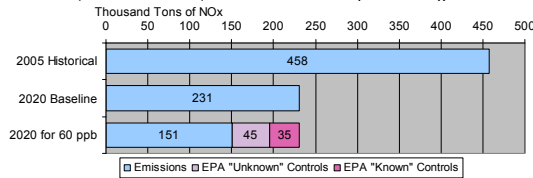
- EPA projects ten Tennessee counties would exceed 60 ppb in 2020 under baseline conditions, with potentially more from expansion of the ozone monitoring network.
- Nonattainment for Memphis, Nashville, Knoxville, and other urban areas in Tennessee would mean restrictions on new facilities and possible loss of federal highway/transit funding.
- Complications with Prevention of Significant Deterioration (PSD) and New Source Review (NSR) pre-construction permits could lead to project delays and/or deferrals.



Sources: EPA, Final Ozone NAAQS RIA (2008), Table 3a.18; NERA analysis of MSAs requiring new ozone monitors

Tennessee Emission Reductions Required to Achieve 60 ppb Ozone Standard in 2020

- To meet a 60 ppb standard, EPA projects 2020 NOx emissions must be 151,000 tons, a reduction of 80,000 tons (35 percent) from the 2020 baseline. NERA relied on this estimate of required reduction for its own analysis.
- EPA estimates that all "known" controls would only reduce Tennessee NOx emissions by 35,000 tons. To reach attainment, reductions of 45,000 tons would be required through "unknown" controls.



Source: NERA analysis of EPA data in Docket No. EPA-HQ-OAR-2007-0225

Study Findings: Tennessee Controls and Attainment Costs

- Where EPA "known" controls reduce NOx emissions by 35,000 tons, NERA/Sierra identified additional controls to reduce Tennessee NOx emissions by an additional 45,000 tons, for a total reduction of 80,000 tons (the total necessary reduction for a 60 ppb standard estimated by EPA).
- Estimated attainment costs for Tennessee—including EPA "known" controls and NERA/Sierra "identified" controls—are \$2.8 billion annually beginning in 2020. The estimated present value of costs from 2020 to 2030 is \$22.1 billion. (All dollars in this report are in 2010 dollars.)

Study Findings: Tennessee Economic Impacts

- The state-of-the-art and widely used REMI Policy Insight model was used to estimate net Tennessee economic impacts (taking into account attainment costs in other states).
- A 60 ppb standard in 2020 would, for Tennessee: reduce jobs by 77,000, a 2.5 percent decrease relative to baseline; reduce gross regional product by \$6.6 billion; reduce disposable income by \$3.9 billion; and reduce state tax revenue by \$0.3 billion.

- On a present value basis from 2020 to 2030, the 60 ppb standard would lead to a \$51.9 billion reduction in Tennessee gross regional product.

	Units	2020	2025	2030	PV
Employment	Jobs	-77,000	-72,000	-58,000	-777,000*
Gross regional product	Billion 2010\$	-\$6.6	-\$6.5	-\$5.7	-\$51.9
Disposable income	Billion 2010\$	-\$3.9	-\$4.6	-\$4.2	-\$35.3
State tax revenue	Billion 2010\$	-\$0.3	-\$0.003	\$0.1	-\$0.6

	Units	2020	2025	2030
Employment	%	-2.5%	-2.2%	-1.7%
Gross regional product	%	-2.3%	-2.0%	-1.5%
Disposable income	%	-1.4%	-1.5%	-1.2%
State tax revenue	%	-0.9%	0.0%	0.3%

Note: Present values ("PV") are sums of annual impacts from 2020 to 2030 discounted to 2020 using a real annual discount rate of 7 percent.
 (*) The PV for employment impacts is an undiscounted sum of person-years.
 Source: NERA analysis as explained in text

Introduction

- Background on Proposed Ozone Standard
- Background on EPA Regulatory Impact Analysis
- Study objectives
- Study approach

Introduction: Background on Proposed Ozone Standard

- In January 2010, the US Environmental Protection Agency (EPA) proposed to reconsider the primary (8-hour) ozone National Ambient Air Quality Standard (NAAQS).
 - The current primary ozone standard is 75 ppb, set in March 2008.*
 - EPA proposed to tighten the primary ozone standard to between 60 and 70 ppb.
 - EPA invited comments on the proposal.
- A tightening of the primary ozone standard would increase the number of counties in the US that would be designated as "nonattainment" counties.
 - Some areas of the US that are in attainment of the current standard would be "nonattainment" areas under a tightened standard.
 - Current "nonattainment" areas could be in a more severe nonattainment category under a tightened standard.
- New and continuing nonattainment areas would need to achieve additional ozone precursor (i.e., NOx and VOC) emission reductions (relative to baseline emissions) to meet a tightened standard.
 - Nitrogen oxides (NOx) and volatile organic compounds (VOC) are ozone precursor emissions—i.e., emissions that lead to ground-level ozone formation in the presence of sunlight.
- Complications with Prevention of Significant Deterioration (PSD) and New Source Review (NSR) pre-construction permits could lead to project delays and/or deferrals.
- Nonattainment status under a tightened standard may be tied to restrictions on federal funding or business growth in nonattainment areas.

* For an area to attain the standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentration measured at each monitor within the area (the area's ozone level) must not exceed the target ozone level.

- EPA published an Updated Regulatory Impact Analysis (RIA) in conjunction with the proposed revisions to the primary ozone standard.
- The EPA Updated RIA, the EPA Final RIA from the 2008 ozone revision, and the EPA ozone rulemaking docket provide the following information relevant to this study:
 - Projected (2020) baseline ozone levels for US counties;
 - Descriptions of the assumed future implementation of various federal and state programs that form the bases for the baseline ozone level projections;
 - A sample ozone precursor emission “control scenario” that takes effect in 2020 across the US and achieves ozone level reductions through a set of NOx and VOC emission controls.
- EPA estimated attainment costs at a national level for a potential 60 ppb ozone standard.
 - EPA modeled the “known” controls (i.e., those that were in its data base or otherwise specified) by area.
 - For areas that would need additional reductions beyond “known” controls, EPA assumed that they could be achieved at costs roughly similar to the highest-cost known controls.
- The EPA RIAs do not provide economic impacts estimates for a potential ozone standard within the range of 60 to 70 ppb.

- The objective of this study is to provide estimates of attainment costs and economic impacts in Tennessee of a potential 60 ppb ozone standard.
 - We model an attainment deadline of 2020 (as assumed by EPA).
 - We model attainment costs and economic impacts relative to projected baseline conditions that would achieve an ozone standard of 84 ppb (the baseline conditions assumed by EPA).
 - We include the potential gains to some businesses from attainment costs (e.g., increased demand for low-emission technologies).
 - We *assume* that it is possible to control emissions to the low levels required for attainment with a 60 ppb standard and develop estimates for additional “identified” controls as well as “extra” controls if necessary to achieve attainment.
- We do *not* model the following:
 - Economic effects associated with potential restrictions on federal funding or business growth in Tennessee due to non-attainment status;
 - Project delays and/or deferrals resulting from complications with PSD/NSR pre-construction permits; and
 - Economic impacts on small businesses (since REMI does not develop information by size of business).
- Key uncertainties in the analysis include the following:
 - Level of emission reductions required in 2020 to achieve a 60 ppb ozone standard;
 - Nature of control measures that are possible to reduce emissions; and
 - Costs of these control measures.

- We use EPA estimates of NOx and VOC emission reductions necessary to achieve a potential 60 ppb ozone standard in Tennessee.
- We use EPA estimates of emission reductions and costs from known controls.
- With assistance from Sierra Research (Sierra), we develop estimates of “identified” emission reductions and costs from other controls not modeled by EPA as well as from “extra” reductions if “identified” reductions are not sufficient for attainment.
- We develop a “marginal cost curve” for emission reductions in Tennessee—i.e., a dataset identifying the various control measures that could contribute to achievement of the ozone targets, ordered in terms of cost per ton.
 - The marginal cost curve shows how the cost per ton increases as more expensive measures are implemented to achieve increasing levels of emission reduction.
- Using the marginal cost curve, we calculate attainment costs for the 60 ppb standard by selecting control options along the marginal cost curve from lowest to highest cost per ton until the target is met; this process ensures that the calculated attainment costs reflect the lowest cost to achieve the 60 ppb ozone standard.
- We use the attainment cost estimates as inputs into the Policy Insight regional economic model, a state-of-the-art model developed and maintained by Regional Economic Models, Inc. (REMI), to assess the potential economic impacts on Tennessee.
 - The REMI model incorporates the direct economic effects of control costs and other regional expenditures as well as indirect and induced effects throughout the regional economy.
 - We present impacts on gross regional product, employment, disposable income, and state tax revenue.

Methodology

- Baseline Ozone Concentrations
- Estimating Reduction Requirements and Attainment Costs
- Estimating Economic Impacts

- Baseline emissions are the NOx and VOC emissions under expected future conditions with an ozone standard of 84 ppb (the baseline ozone standard assumed in the EPA 2008 and 2010 RIAs).
- The EPA RIAs provide projected baseline ozone levels for US counties in 2020 and describe the assumptions about future implementation of various federal and state programs that form the bases for the ozone level projections.
 - Baseline emissions in the EPA RIAs are intended to account for economic growth and reductions expected from all “on-the-books” local and federal regulations, including existing local commitments to meet the 84 ppb ozone standard and federal programs to reduce NOx or VOC emissions from various sources (e.g., the Clean Air Interstate Rule).
- We use the information in the EPA RIAs to project 2020 baseline NOx and VOC emissions in Tennessee.

- We use information on necessary emission reductions in Tennessee from the EPA RIAs.
- We use the costs of EPA “known” controls from the EPA RIAs that reflect the control alternatives and their costs that EPA identified for 2020.
- NERA and Sierra develop a marginal abatement cost curve to show the costs of attaining a 60 ppb ozone standard in the least-cost manner. This curve includes EPA “known” controls, NERA/Sierra “identified” controls, and NERA/Sierra “extra” controls in situations in which these other categories are not sufficient to achieve compliance.
- NERA and Sierra identify the following additional controls that potentially could be used in Tennessee and elsewhere in the US to reduce emissions beyond EPA known controls.
 - Electric generating units: Retirement of existing coal units and replacement with natural gas combined cycle units.
 - Onroad mobile: Retirement (scrapping) of pre-2015 model year vehicles and replacement with more fuel-efficient vehicles.
 - Commercial marine: Retrofit of local commercial marine vessels with selective catalytic reduction (SCR) technology.
 - Area sources: Replacement of existing natural gas space heaters with more fuel-efficient natural gas units.
- The appendix to this report lists the types of “known” controls reported by EPA and the additional controls identified by NERA/Sierra.
- The costs of “extra” NOx reductions (if necessary) are assumed to increase beyond the most expensive identified controls at the same rate assumed by EPA for “unknown” controls.

- We use the control cost estimates for a potential 60 ppb ozone standard as inputs into the Policy Insight regional economic model, a state-of-the-art model developed and maintained by Regional Economic Models, Inc. (REMI).
 - The REMI model is used by numerous local, state and federal governments to evaluate the economic impacts of projects and policies.
- Attainment of a potential 60 ppb ozone standard would require implementation of control measures that would impose direct costs in Tennessee.
 - Tennessee industries would incur increased production costs associated with the installation or use of emission control technologies and strategies.
 - Tennessee taxpayers would incur increased taxes associated with increased local government expenditures on emission control programs.
 - The cost of living in Tennessee would rise due to regulations on consumer products.
 - Note, however, that some businesses would gain from the additional demand for control measures (e.g., low-emission technologies).
- The REMI model captures the direct impacts in Tennessee associated with attainment of the potential ozone standard in 2020, as well as the secondary indirect and multiplier effects that result as the direct effects work their way through the state economy.
- We estimate changes in costs for businesses and households and assign these changes in costs to the appropriate industry and household categories in REMI.

- The REMI model includes baseline projections for various economic variables and outputs (e.g., industry sector relative production costs, consumer product prices, gross regional product, employment by industry sector and occupation, and income, among others).
 - Baseline values in REMI are tailored to individually modeled regions and incorporate projected economic growth.
- We present the economic impacts of attainment of the potential 60 ppb ozone standard as differences from projected baseline economic conditions.
 - Inputs enter the REMI model as modifications to the baseline values of relevant economic variables.
 - The REMI model produces estimates of the effects of inputs as impacts on other economic variables and outputs relative to the baseline.

Results

- Baseline ozone concentration
- Marginal abatement cost curve
- Total attainment costs
- Economic impacts

Results: Baseline 2020 Ozone Concentrations in Tennessee

- As shown in the map below, 17 counties in Tennessee currently have ozone monitors, and EPA projects that ten of these counties would exceed 60 ppb in 2020 under baseline conditions.
- Expansion of ozone monitoring to include monitors in the Cleveland, Jackson, and Johnson City Metropolitan Statistical Areas would likely increase the number of nonattainment counties.

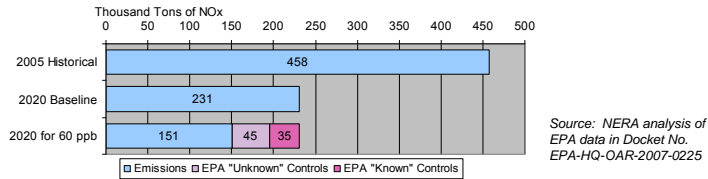


Concentration Counties	
>60 ppb	10
≤60 ppb	7
No Data	78
New Monitoring Area	

Note: The Cleveland, Jackson, and Johnson City Metropolitan Statistical Areas are likely to require ozone monitors by 2012.
Sources: EPA, Final Ozone NAAQS RIA (2008), Table 3a.18;
NERA analysis of MSAs requiring ozone monitors

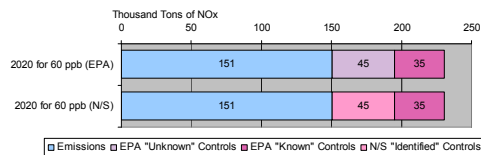
Results: EPA 2020 Emission Reductions

- To meet a 60 ppb standard, EPA projects NOx emissions in Tennessee in 2020 must be 151,000 tons, a reduction of 80,000 tons (35 percent) from the 2020 baseline. NERA relied on this estimate of required reduction for its own analysis.
- EPA estimates that all "known" controls would reduce Tennessee NOx emissions by only 35,000 tons (44 percent of the necessary reduction from the 2020 baseline). To reach attainment, reductions of 45,000 tons would be required through "unknown" controls.

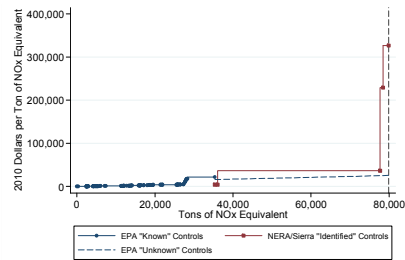


Results: NERA/Sierra 2020 Emission Reductions

- The figure below compares NERA/Sierra estimates of Tennessee NOx emission reductions in 2020 with EPA estimates.
 - NERA/Sierra "identified" controls would reduce NOx emissions by an additional 45,000 tons (56 percent of the necessary reduction from the 2020 baseline).



- The figure at right shows the cost per ton of increasingly expensive EPA and NERA/Sierra controls in Tennessee.
 - EPA's cost estimate for the most expensive "known" control is \$22,000 per ton. The lower dashed line shows EPA's assumption on the cost per ton of "unknown" controls.
 - NERA/Sierra's cost estimates for "identified" controls range from \$4,000 to \$327,000 per ton.
- The estimated attainment cost for Tennessee is \$2.8 billion annually beginning in 2020.
 - The estimated present value of costs from 2020 to 2030 is \$22.1 billion (as of 2020 using a real annual discount rate of 7 percent).



Note: EPA "unknown" controls reflect the Hybrid Mid extrapolation approach; VOC is converted to NOx equivalents using impact ratios from EPA (2007). Source: NERA analysis as explained in text.

Results: Tennessee Economic Impacts

Estimated Economic Impacts on Tennessee of
EPA 2010 Ozone Proposal

- The table below summarizes the estimated economic impacts in Tennessee of a 60 ppb ozone standard in 2020, 2025 and 2030 relative to baseline projections.

Baseline	Units	2020	2025	2030	
Employment	Million Jobs	3.1	3.2	3.3	
Gross regional product	Billion 2010\$	\$290	\$328	\$374	
Disposable income	Billion 2010\$	\$277	\$309	\$350	
State tax revenue	Billion 2010\$	\$38	\$41	\$45	

Change	Units	2020	2025	2030	PV
Employment	Jobs	-77,000	-72,000	-58,000	-777,000*
Gross regional product	Billion 2010\$	-\$6.6	-\$6.5	-\$5.7	-\$51.9
Disposable income	Billion 2010\$	-\$3.9	-\$4.6	-\$4.2	-\$35.3
State tax revenue	Billion 2010\$	-\$0.3	-\$0.003	\$0.1	-\$0.6

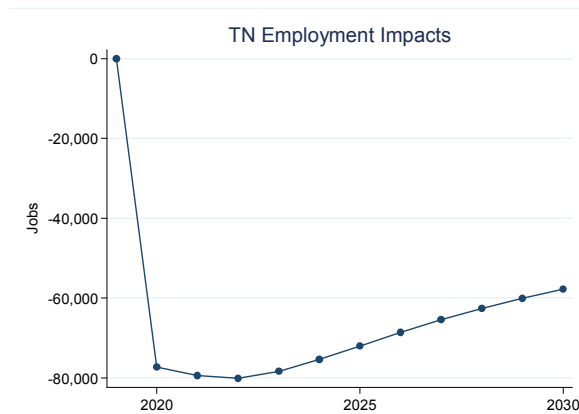
% Change	Units	2020	2025	2030	
Employment	%	-2.5%	-2.2%	-1.7%	
Gross regional product	%	-2.3%	-2.0%	-1.5%	
Disposable income	%	-1.4%	-1.5%	-1.2%	
State tax revenue	%	-0.9%	0.0%	0.3%	

Note: Present values ("PV") are sums of annual impacts from 2020 to 2030 discounted to 2020 using a real annual discount rate of 7 percent.
 (*) The PV for employment impacts is an undiscounted sum of person-years.
 Source: NERA analysis as explained in text

Results: Tennessee Employment Impacts by Year

Estimated Economic Impacts on Tennessee of
EPA 2010 Ozone Proposal

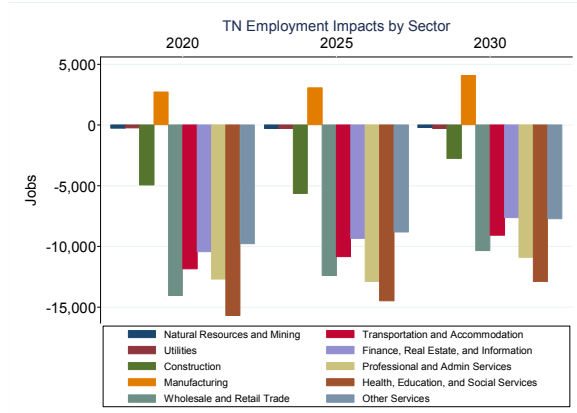
- Tennessee employment in 2020 is projected to decrease by 77,000 jobs (2.5 percent relative to baseline).



Note: The change in jobs shown for a given year is the total difference in jobs relative to the baseline in the given year.
 Source: NERA analysis as explained in text

Results: Tennessee Employment Impacts by Sector

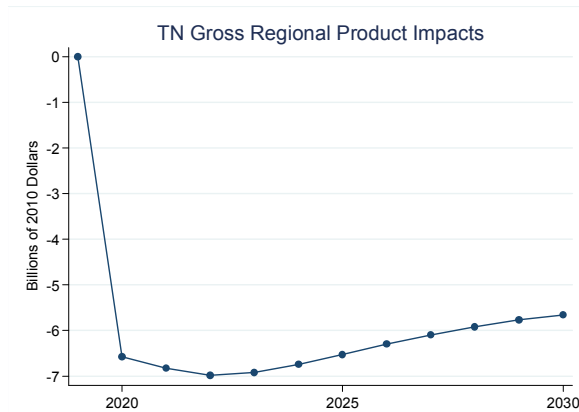
- The figure below shows estimated changes in Tennessee employment by sector in 2020, 2025, and 2030 due to a potential 60 ppb ozone standard. The positive estimated impacts for manufacturing reflect potential production in Tennessee of low-emission technologies.



Note: The change in jobs shown for a given year is the total difference in jobs relative to the baseline in the given year.
Source: NERA analysis as explained in text

Results: Tennessee Gross Regional Product Impacts by Year

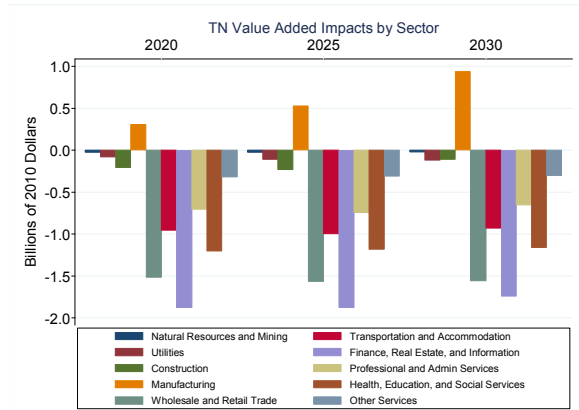
- Tennessee gross regional product in 2020 is projected to decrease by \$6.6 billion (2.3 percent relative to baseline).



Note: Gross regional product measures of the value of goods and services produced in an area's regional economy.
Source: NERA analysis as explained in text

Results: Tennessee Value Added Impacts by Sector

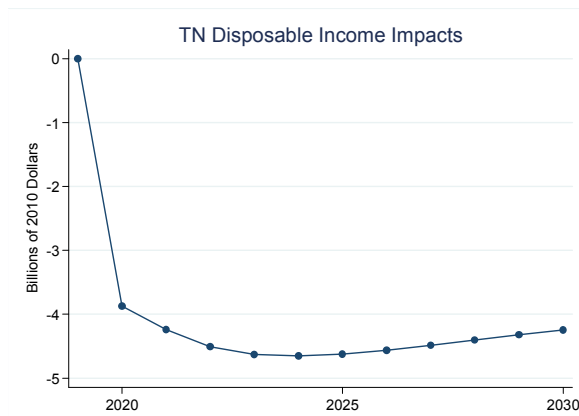
- The figure below shows estimated changes in Tennessee value added by sector in 2020, 2025, and 2030 due to a potential 60 ppb ozone standard. The positive estimated impacts for manufacturing reflect potential production in Tennessee of low-emission technologies.



Note: Industry value added is the value of output from a particular industry less the value of intermediate goods; the sum of value added from all sources in a region is the gross regional product of the region (i.e., the value of goods and services produced in the regional economy).
 Source: NERA analysis as explained in text

Results: Tennessee Disposable Income Impacts by Year

- Tennessee disposable income in 2020 is projected to decrease by \$3.9 billion (1.4 percent relative to baseline).



Source: NERA analysis as explained in text

- US Environmental Protection Agency. 2007. *Regulatory Impact Analysis of the Proposed Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone*. July.
- US Environmental Protection Agency. 2008. *Final Ozone NAAQS Regulatory Impact Analysis*. March.
- US Environmental Protection Agency. 2010. *Summary of the Updated Regulatory Impact Analysis (RIA) for the Reconsideration of the 2008 Ozone National Ambient Air Quality Standard (NAAQS)*. January.
- US Environmental Protection Agency. 2010. Ozone Rulemaking Docket. EPA-HQ-OAR-2007-0225.

Appendix: Lists of Control Measures

- Electric Generating Units
- Non-EGU Point
- Area
- Onroad Mobile
- Nonroad Mobile

EPA “Known” Controls

- Lower ozone season nested caps in OTC and MWRPO states while retaining the current CAIR cap and a new cap for Eastern Texas.
- Application of local controls (SCR and SNCR) nationally to coal fired units in and around NA counties covering the combination of CBSA (Core based Statistical Areas) and CSA (Combined Statistical Areas) outside of OTC, MWRPO, and East Texas.

NERA/Sierra “Identified” Controls

- Replace coal-fired plants with combined-cycle natural gas turbines

EPA “Known” Controls

- Biosolid Injection Technology
- LNB (Low NOx Burner)
- LNB + FGR (Flu Gas Recirculation)
- LNB + SCR (Selective Catalytic Reduction)
- NSCR (Non-selective Catalytic Reduction)
- OXY-Firing
- SCR
- SCR + Steam Injection
- SCR + Water Injection
- SNCR (Selective Non-catalytic Reduction)
- SNCR—Urea
- SNCR—Urea Based
- Permanent Total Enclosure (PTE)
- Work Practices, Use of Low VOC Coatings (Non-EGU Point Sources)

NERA/Sierra “Identified” Controls

- None

Lists of Control Measures: Area

Estimated Economic Impacts on Tennessee of
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EPA “Known” Controls

- RACT to 25 tpy (LNB)
- Switch to Low Sulfur Fuel
- Water Heater + LNB Space Heaters
- CARB Long-Term Limits
- Catalytic Oxidizer
- Equipment and Maintenance
- Gas Collection (SCAQMD/BAAQMD)
- Incineration >100,000 lbs bread
- Low Pressure/Vacuum Relief Valve
- OTC Mobile Equipment Repair and Refinishing Rule
- OTC Solvent Cleaning Rule
- SCAQMD—Low VOC
- SCAQMD Limits
- SCAQMD Rule 1168
- Work Practices, Use of Low VOC Coatings
- Switch to Emulsified Asphalts

NERA/Sierra “Identified” Controls

- Replace natural gas space heaters in residential buildings with more energy-efficient natural gas appliances
- Replace natural gas space heaters in commercial buildings with more energy-efficient natural gas appliances

Lists of Control Measures: Onroad Mobile

Estimated Economic Impacts on Tennessee of
EPA 2010 Ozone Proposal

EPA “Known” Controls

- Diesel Retrofits
- Reduce Gasoline Reid Vapor Pressure (RVP) to 7.0
- Elimination of Long Duration Idling
- Continuous Inspection and Maintenance
- Commuter Programs
- Additional Technology Changes in the Onroad Transportation Sector
- Increased Penetration of Onroad SCR and DPF from 25% to 75%
- Continuous Inspection and Maintenance (OBD)

NERA/Sierra “Identified” Controls

- Replace pre-2015 model year light-duty gasoline vehicles (passenger cars and light trucks) with more energy-efficient vehicles

EPA "Known" Controls

- Diesel Retrofits and Engine Rebuilds
- Reduce Gasoline Reid Vapor Pressure (RVP) to 7.0
- Aircraft NOx International Standard
- Increased Penetration of Nonroad SCR and DPF from 25% to 75%

NERA/Sierra "Identified" Controls

- Install SCR on Category 1 and 2 engines for local commercial marine vessels (distillate-powered tugs, dredgers, commercial excursion, ferries, fishing, and other non-governmental support vessels)

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