
Clearing Up the Smog

Debunking Industry Claims that We Can't Afford Healthy Air

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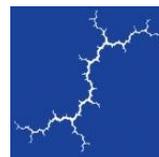
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GLOSSARY OF TERMS

BACT: Best Available Control Technology

CPP: Clean Power Plan

EGU: Electric Generating Unit

EPA: Environmental Protection Agency

GW: Gigawatt

kW: Kilowatt

LNB: Low NOx Burner

MMBtu: Million British Thermal Units

MW: Megawatt

MWh: Megawatt hour

NAAQS: National Ambient Air Quality Standard

NLEV - National Low Emission Vehicle (Standard)

NOx: Oxides of Nitrogen

RIA: Regulatory Impact Assessment

SCR: Selective Catalytic Reduction

TCEQ: Texas Commission on Environmental Quality

VOC: Volatile Organic Compound



EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) has proposed to strengthen the national clean air standard for ozone to protect public health. Ground-level ozone (the primary constituent of smog) contributes to respiratory damage, asthma attacks, lung disease, damage to the cardiovascular system, hospitalizations and premature deaths. Ozone is formed from air pollution emitted by power plants, factories, motor vehicles, and other sources. According to EPA's independent science advisors and leading medical organizations, the current ozone standard is not adequate to protect children, seniors, asthmatics, and others from serious harm. EPA has specifically proposed to strengthen the current standard of 75 parts per billion (ppb) to a level within a range of 65 to 70 ppb.

In February 2015, NERA Economic Consulting issued a report for the National Association of Manufacturers making extreme claims about the cost and job impacts of meeting a 65 ppb standard. NERA's cost estimates are more than ten times higher than those made by EPA in its 2014 Regulatory Impact Assessment (RIA) for the proposed standards.

The NERA report grossly overstates compliance costs, due to major flaws, math errors, and unfounded assumptions in NERA's analyses. Among other things:

- NERA significantly inflated the emission reductions needed to meet the 65 ppb standard through a series of unfounded and skewed assumptions. These assumptions and other flaws led NERA to overstate compliance costs by more than 700 percent.
- Applying a more reasonable estimate of needed emission reductions to EPA's cost estimation approach yields an annual cost figure \$1.4 billion/year *lower* than EPA's projected cost of meeting the 65 ppb standard.
- NERA grossly inflated the cost of meeting a revised standard not only by assuming greater emission reductions than needed, but by basing the expense of those reductions on the "cash for clunkers" program, designed to incentivize consumer spending, not emissions reductions.
- NERA's analysis, as presented to EPA, suffers from a math error of about \$70 billion – nearly half of NERA's annualized cost estimate.
- NERA's claims that a revised standard will lead to significant job losses and harm to the economy are unfounded and unsupportable.
- NERA fails to account for the significant health and economic benefits of a stronger standard, benefits that EPA has valued at \$19 to \$38 billion annually outside of California, and \$2.2 to \$4.1 billion per year in California.



NERA's Flawed Methodology

Overall, the main thrust of NERA's attack focused on the cost of reducing NO_x (a key ozone-forming pollutant), particularly from "unknown controls" (future innovations to reduce pollutants). NERA greatly overestimates both the amount of needed unknown controls and the costs of these controls.

- **Need for unknown controls.** EPA estimates that states would need to obtain about 750,000 tons of NO_x emissions reductions through unknown controls to meet the 65 ppb standard. NERA increases this number to 1,000,000 tons of reductions, and prices the reductions at an extraordinary cost.
 - It is difficult to assess why NERA chose a significantly higher quantity of unknown controls, because NERA's assessment is poorly documented and uses values that are inconsistent with the RIA. In addition, NERA's assessment appears to draw some values from the RIA for reference, and re-creates other values from its proprietary model. Synapse re-constructed EPA's estimated NO_x emissions reduction requirements, and compared these against NERA's assumptions.
 - NERA overestimates the level of NO_x reductions that are required to meet a 65 ppb ozone standard, which erroneously bumps up the need for unknown controls.
 - NERA disqualifies EPA's Clean Power Plan as a mechanism for achieving NO_x reductions, unnecessarily increasing the amount of needed unknown controls.
- **Cost of unknown controls.** NERA bases its estimate of the marginal cost of reducing NO_x on a single, flawed data point: a simplified analysis of the estimated benefits of scrapping older vehicles under the Car Allowance Rebate System (CARS). NERA arrives at a cost of about \$500,000 per ton of NO_x, an extraordinary cost relative to any other estimate. This cost ends up driving NERA's exorbitantly high estimate of the cost of compliance.
 - An alternative analysis of the cost of the CARS program found costs of reducing CO₂ emissions 2-4 times lower than the study used by NERA. Assuming that NO_x and CO₂ benefits scale linearly, the analysis selected by NERA presents inappropriately high NO_x costs.
 - The CARS program was not designed to reduce NO_x specifically, and therefore was probably an ineffective mechanism towards targeting this specific pollutant.
 - NERA assumes one million tons of emissions reductions from vehicle scrapping: substantially higher than the amount of needed unknown controls assumed by EPA. This would lead to excess and unnecessary compliance costs.
- **Erroneous Math.** NERA double counts and massively inflates control costs at coal-fired EGUs, counting both the actual assessed costs for controls as well as a cost based on the inflated cost curve.



- Of NERA's 1.8 million tons on "unknown controls," 800,000 are associated with coal plant retirements and retrofits, which have a known cost, tallied up by NERA. However, NERA assesses the total cost of compliance by including all 1.8 million tons in their "unknown control" cost curve, thereby inflating the size of the cost curve, replacing known control costs with inflated notional unknown control costs, and double counting the cost of emissions reductions at coal-fired power plants.
- NERA's public presentations to EPA and the Texas Commission on Environmental Quality (TCEQ) report incorrect information based on the double-counted data, inflating costs by nearly 200%.

NERA's cost of unknown controls exceeds anything contemplated in EPA's RIA by an order of magnitude. And while EPA's RIA is based on an extensive literature basis for emissions reduction requirements, cost estimates, and the history of emissions compliance costs, NERA's "evidence based" report is based on a single study.

Synapse Re-Analysis

There is one critique NERA has of EPA's cost assessment that Synapse does agree with: economic coal plant retirements should be captured in an economic assessment of the ozone standard. We re-conducted portions of NERA's assessment to generate what we believe to be corrected costs for this purpose.

Using EPA's updated estimates of what emissions would be in 2025 after compliance with the final Clean Power Plan, we deducted explicit controls and additional reductions to the "baseline" (an estimate of emissions at the future date if states and regions apply controls to stay within the current ozone standard of 75 ppb) based on data in EPA's Regulatory Impact Assessment (RIA) for the Clean Power Plan. We followed EPA's assumptions for all known controls except for power plant controls. We assumed that (1) all coal-fired power plants that emit above 0.17 lbs of NO_x per MMBtu would require advanced controls or retire, and (2) units below 250 megawatts (MW) would retire economically, at the same cost as the retrofit, to be replaced with a controlled natural gas combined-cycle unit.

The analysis resulted in 360,000 tons of NO_x reductions from existing coal-fired EGU through retrofit and replacement – or 150,000 tons more than estimated by EPA. Accounting for the less stringent standard in the final Clean Power Plan then proposed, we found a remaining gap requiring unknown controls of 660,000 tons – substantially less than EPA's estimate of 750,000 tons of unknown emissions reductions.

We met the remaining unknown controls using a cost curve half as steep as NERA's marginal cost curve. The CARS program, upon which NERA's marginal cost is based, was not designed to control NO_x emissions in an economically efficient way. Other studies, aside from the one relied upon by NERA, have found that the emissions reductions realized by the CARS program were at least twice as cost effective as NERA's estimate. It is unreasonable to rely on a single study, with a selectively high cost, of an inefficient program. Even holding NERA's assumption that the marginal cost abatement would require a car scrappage type of program, with the more reasonable cost curve, annualized cost for known and



unknown controls for the year 2025 would be \$21.5 billion – or about 1/7th of NERA’s estimated costs. Applying the same analysis of NO_x reductions available from existing coal-fired EGU retrofits and replacements to EPA’s methodology for calculating cost produces annualized costs for known and unknown controls for 2025 of \$13.6 billion, or \$1.4 billion *lower* than the estimate in EPA’s assessment.

Economic Impact

In addition to exaggerating the costs of compliance, NERA provides an overblown estimate of the effect the revised ozone standard will have on the economy as a result of those costs. NERA’s analysis concludes that the 65 ppb ozone rule will result in the loss of 1.4 million job-equivalents. This economic impact estimate is flawed for several reasons. First, NERA’s economic impact estimates would decrease with more realistic cost assumptions. NERA also erroneously assumes that pollution controls reduce economic activity elsewhere, an assumption that does not comport with the functions of the economy today. When there is slack in the economy and investment is limited by the lack of profitable opportunities rather than the lack of funds (as is frequently, and currently, the case), then emission control requirements can lead companies to borrow more or spend their idle cash rather than pull back from other investments, stimulating the economy. According to NERA, high compliance costs will also force wages down and thus reduce productivity, as workers will have decreased incentive, but the evidence simply does not support these claims.

Significantly, NERA does not predict actual job losses from a stronger ozone standard. NERA reports economic impacts in terms of “job-equivalents,” its proprietary model’s prediction of reduced labor income divided by the average labor income per job. Despite the fact that the report discusses the fact that *a decrease in job-equivalents does not mean that actual jobs will be lost*, most others reporting on the study have either missed or disregarded this critical point, including the entity that funded the study (the National Association of Manufacturers).



1. INTRODUCTION

In January, 2010, the US Environmental Protection Agency (EPA) proposed to strengthen the National Ambient Air Quality Standard (NAAQS) for ground-level ozone to protect the health of Americans and reduce environmental impacts. Ground-level ozone (the primary constituent of smog) contributes to upper respiratory damage, asthma attacks, lung disease, damage to the cardiovascular system, and premature deaths. The proposed revision would have strengthened the standard from the current level of 75 parts per billion (a measure of atmospheric concentration) to 60 to 70 ppb. In September 2011, the President directed EPA to withdraw the proposal, stating that the agency should defer consideration of a stronger standard until 2013. A new proposal for ozone was issued in November, 2014, proposing to tighten the standard between 65 and 70 ppb, with an “alternative” standard set at 60 ppb.

The Clean Air Act bars EPA from considering costs when setting air quality standards, which must be based solely on protection of public health. Nonetheless, EPA regularly prepares a Regulatory Impact Analyses (RIA) assessing costs and benefits for informational purposes.¹ EPA released a supplemental RIA accompanying the withdrawn 2010 proposal, showing a range of costs and benefits at both the 60 and 70 ppb levels.² In the revised 2014 proposal EPA issued a more comprehensive RIA (2014 RIA),³ finding net benefits for both a 65 and 70 ppb standard and, for the nation outside of California, a range from a net cost to net benefits for the 60 ppb alternative standard (see Table 1 & 2). The RIA further found net benefits in California at all levels of the standard being considered.

Table 1. Total annual costs and benefits of the revised proposed ozone standard (7% discount rate) in 2025 outside of California. 2014 RIA, Table ES-6. Billions of 2011\$.

	70 ppb	65 ppb	60 ppb
Total costs	\$3.9	\$15	\$39
Health benefits	\$6.4-\$13.0	\$19-\$38	\$34-\$70
Net benefits	\$2.5-\$9.1	\$4-\$23	(\$5)-\$31

¹ In addressing cost estimates, this report is not in any way intended to suggest that the President, OMB or EPA can lawfully consider costs in setting the ozone NAAQS. As indicated in the text, consideration of costs is flatly prohibited in the standard setting stage.

² EPA. January 7, 2010. Supplement to the Regulatory Impact Analysis for Ozone. <http://www.epa.gov/airquality/ozonepollution/pdfs/fs20100106ria.pdf>

³ EPA. November 2014. Regulatory Impact Analysis of the Proposed Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone. <http://www.epa.gov/ttn/ecas/regdata/RIAs/20141125ria.pdf>



Table 2. Total annual costs and benefits of the revised proposed ozone standard (7% discount rate) in 2025 in California. 2014 RIA, Table ES-10. Billions of 2011\$.

	70 ppb	65 ppb	60 ppb
Total costs	\$0.8	\$1.6	\$2.2
Health benefits	\$1.1-\$2.0	\$2.2-\$4.1	\$3.2-\$5.9
Net benefits	\$0.3-\$1.2	\$0.6-\$2.5	\$1.0-\$3.7

In July 2014, NERA Economic Consulting, working on behalf of the National Association of Manufacturers (NAM), produced a report criticizing EPA’s 2010 RIA, and preparing for the expected re-release of the revised ozone standard. Shortly after EPA released the 2014 proposed revision, NERA produced another report attacking the 2014 RIA and the revised standard. Overall, the main thrust of NERA’s attack focused on the cost of reducing emissions for oxides of nitrogen (NOx), particularly reductions from control measures other than those explicitly identified by EPA. In fact, NERA’s first analysis suggested that reducing NOx emissions to meet a revised standard of 60 ppb would reduce Gross Domestic Product (GDP) by \$270 billion each year, or almost 2% of the national GDP. Their re-issued critique in 2015 addressing a 65 ppb standard tamped down their expected reduction of GDP to \$140 billion (or 1% of total GDP), with an annualized cost of pollution controls of \$155 billion.⁴

How did NERA get to these extreme estimates, while EPA estimated pollution controls costs only 1/10th as great? This paper explores NERA’s two driving assumptions – and simply erroneous math – that elevated the cost of the 65 ppb standard by \$140 billion – from the \$15 billion estimated by EPA up to \$155 billion. While EPA’s decision to revise the standard is based on thousands of peer reviewed studies,⁵ and the RIA was subject to public comment and grounded in dozens of public health and economic studies, NERA relied on one untested and non-vetted assumption based on one non-reviewed study, and a model whose details are hidden from public scrutiny. Over the last year, NAM and NERA have presented and pushed NERA’s report in an effort to attack a stronger ozone standard. A review of NERA’s analysis, however, shows a severely inflated cost estimate, biased data selection, inconsistent assumptions, and significant math errors. This paper reviews NERA’s studies and assumptions, and corrects several of NERA’s missteps to arrive at a far more reasonable cost estimate.

1.1. The Cost of Reducing Ozone Pollution

Ground-level ozone, a primary constituent of smog, is formed in the atmosphere in a chemical reaction between volatile organic compounds (VOCs) and oxides of nitrogen (NOx), in the presence of strong sunlight. Because it is not directly released from a stack, ozone forms over wide areas and is a regional

⁴ “Assessing the Potential Economic Impacts of a 65 ppb Ozone NAAQS.” Stakeholder presentation with US EPA, June 18, 2015. Page 7. Filed in docket as EPA-HQ-OAR-2008-0699-4003.

⁵ See EPA, 2013. Integrated Science Assessment (ISA) for Ozone (O3) and Related Photochemical Oxidants. http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=511347



pollutant. A NO_x source in one state can be responsible for ozone formation hundreds of miles downwind. EPA has typically considered ozone to be an interstate problem.

NO_x, often the primary limiting constituent of ozone, is primarily released from engines and boilers as a byproduct of combustion. Over the last decades, the technology for reducing NO_x formation at the point of combustion, as well as capturing NO_x before it leaves the stack or tailpipe has improved dramatically. Today, power plants can install systems to capture over 90% of their NO_x emissions (called Selective Catalytic Reduction, or SCR), and vehicle engine and tailpipe controls have reduced (and will continue to reduce) emissions from new cars and trucks by nearly two orders of magnitude (100 times). Improvements at industrial boilers, farm and construction equipment, and other engines all have the potential to substantially reduce NO_x emissions.

1.2. NERA's Cost of Controls

NERA does not contest the cost of the vast majority of controls found by EPA. In fact, of the 79,000 controls characterized by EPA, NERA adjusts only 150 (at power plants) and the effect of NERA's adjustment is minor. In fact, the NERA report primarily critiqued only one specific element of the RIA – EPA's cost of unknown controls. "Unknown controls" are as yet unidentified emissions reduction programs or technologies that EPA believed would be needed to produce attainment of the ozone standard in all states outside of California. Because deadlines for meeting the ozone standard can extend into the 2030s, EPA believed it was reasonable to assume that new programs and technologies would be developed to serve the need to reduce ground level ozone, as has always been the case in the past. The entirety of NERA's rhetoric about the cost of the proposed 2010 regulation was based on an assumption that unknown controls would cost in excess of twenty (20) times more than EPA's highest control cost estimate.

EPA re-proposed a revised ozone standard in December 2014, with a proposed range of 65 to 70 ppb. The proposal also indicated that EPA would take comment on standard levels down to 60 ppb. Three months later NERA produced a report, critiquing EPA's updated (November 2014) RIA. While the RIA continued to review three levels of stringency at 60, 65 and 70 ppb, NERA's report now shifted to critique the RIA's conclusions as to costs of attaining a 65 ppb standard, largely re-hashing the same thematic elements in NERA's July 2014 paper. Again, NERA found that the 65 ppb standard would be far more expensive than EPA's estimates, and once again the finding was based almost exclusively on the assumption that unknown controls were well over an order of magnitude more expensive than EPA's assumptions. But this time, NERA didn't simply attach a new dollar figure to EPA's unknown controls: It arbitrarily increased the amount of reductions from unknown controls required in the analysis, moving past EPA's assumptions significantly. NERA's re-tuned document again found that the ozone regulation would be far more costly than estimated in the RIA, a finding that rests on two numbers: the amount of emission reductions needed from unknown controls required to meet the standard, and the cost of those controls.



This paper reviews NERA’s assessment, focusing on three elements of NERA’s analysis: (a) the tons of emission reductions expected to be needed from unknown controls, (b) the cost of those unknown controls, and (c) the economic impact of meeting the 65 ppb ozone standard.

We find that NERA’s assessment of emission reductions needed from unknown controls is unsupported by the evidence, is vastly overestimated, and double-counts much of the cost of compliance. We also find that NERA selected a farfetched proxy for unknown controls – namely, a “cash for clunkers” program - that simply does not provide a credible basis for estimating NOx reduction costs, and that NERA selectively used a study with unusually high program cost estimates. Finally, we show that NERA’s economic model is poorly tuned for evaluating economy-wide impacts, selectively ignoring economic benefits and grossly over counting losses.

Overall, NERA’s assessment of the cost impacts of the revised ozone standard at 65 ppb is dramatically exaggerated: even if we assume that NERA’s method of estimating unknown control costs is correct, NERA’s analysis overstates costs by more than 700%.

2. UNKNOWN CONTROL REQUIREMENTS

2.1. Unknown Controls in the RIA

Criteria pollutant NAAQS are set at a national level, meaning that all states and territories must meet the uniform standard. However, states are welcome to find mechanisms that work for their own reduction requirements, and states are charged by EPA to implement their own air quality improvement plans, called “state implementation plans.” In evaluating the cost of compliance in the RIA, EPA strives to create a plausible compliance scenario, but does not limit the methods by which states can or should reach compliance, as long as those methods assure permanent and enforceable pollution reductions. To create this scenario, EPA goes through four steps.

First, EPA creates the “Base Case”, an estimate of emissions at a future date (2025) if there were no additional compliance requirements for the existing or revised ozone NAAQS. The energy and transportation sector evolve along their current projected pathways. EPA marks total emissions expected under this circumstance.

Second, EPA creates the “Baseline,” an estimate of emissions at the future date after implementation of the Clean Power Plan,⁶ and if Texas and California apply incremental controls to meet the current ozone standard of 75 ppb. Based on these reductions, EPA evaluates ozone “design values” in every county –

⁶ In creating the ozone proposal baseline, EPA evaluated the NOx emissions impact of the Clean Power Plan proposed rule, issued in June 2014. The final version of the Clean Power Plan, released August 3, 2015, was not yet available for the RIA.

i.e., modeled concentrations of ozone at theoretical monitors. EPA finds 34 states that would have ozone exceedances in at least one county.

Third, EPA creates individual compliance scenarios to determine the total tons of emissions that would need to be reduced in those 34 states from the Baseline to allow all counties to meet the standard.

Fourth, EPA finds emissions controls in each of five regions that it can use to meet the emissions reduction target, such as catalytic reduction devices, low NOx burner technologies, and cleaner diesel engines for farm and construction vehicles.

The specific named controls are referred to as “known controls,” and are assigned an explicit cost depending on the control. If, after having applied the known controls, EPA still projects a need for additional reductions to attain the standard, the agency allocates those reductions to “unknown” controls. Unknown controls are not specifically identified by EPA, but can include a multitude of projects to cut NOx emissions including both end-of-pipe pollution controls, improvements in industrial plant efficiency, energy efficiency programs, and other measures. Examples include:

- **EGU Displacement:** Displacing high emissions electric generating units (EGU) with renewable energy or energy efficiency can significantly reduce emissions from the electric sector. For example, reducing fossil energy requirements in the Southeast by just 2% could cut 16,000 tons of NOx emissions; ramping to 10% energy efficiency savings through the compliance period could reduce emissions by over 77,000 tons in the Southeast alone – a significant increment.⁷
- **EGU Replacement:** Over the last five years, an increasing number of coal-fired EGUs have been taken offline as owners and operators realize that these units cannot be sustained economically. Falling gas and electricity prices, flat demand, increasing renewable energy, rising coal prices, and other regulations designed to cut toxic emissions and effluent have all made the existing fleet much more expensive to operate than alternatives. In general, the least controlled coal-fired units have retired first. These units are generally replaced by either low or no emissions resources, including gas generators with emissions controls, and renewable energy. The ancillary benefit to NOx emissions reductions can be significant. For example, an 800 MW uncontrolled coal unit might emit 13,000 tons of NOx every year.⁸ Applying an SCR would reduce emissions to about 2,300 tons,⁹ but retiring the unit and replacing it with a controlled natural gas unit would drop emissions to just 300 tons NOx per year,¹⁰ almost completely eliminating

⁷ Data from EPA’s AVERT model, using 2013 Regional Data Files for Southeast and 2-10% portfolio-based demand reduction over all hours of the year.

⁸ 800 MW @ 75% capacity factor, 10 MMBtu/MWh heat rate, and 0.48 lbs NOx/MMBtu emissions rate (bottom quartile of uncontrolled plants).

⁹ Assuming emissions rate with SCR at 0.09 lbs NOx/MMBtu (US fleet wide median for coal with SCRs; source: 2014 Air Markets Program Data).

¹⁰ Assuming controlled gas emissions rate of 0.02 lbs NOx/MMBtu (US fleet wide average for gas NGCC with SCRs; source: 2014 Air Markets Program Data), and gas heat rate of 7.5 MMBtu/MWh, 75% capacity factor.



the emissions source. Replacing the unit with renewable energy and efficiency would, of course, drive this number to nearly zero. SNL has estimated that 46,000 MW of coal (some of which is controlled for NOx) might retire economically between 2012 and 2022.¹¹ Experience has shown that, in general, retiring coal units does not necessarily entail significant incremental cost; indeed, economic unit retirements occur because retiring a unit is less costly than engaging in other capital upgrades. EPA does not consider EGU replacement as an option within “known controls,” and thus this type of strategy would have to be characterized under “unknown controls.”

- **Market-based Programs:** Since 1999, states and EPA have used market-based trading programs to reduce interstate NOx emissions. Under the Ozone Transport Commission (1999-2002), then the NOx SIP call (2003-2008)¹² and finally under the Clean Air Interstate Rule (CAIR, 2009-present),¹³ electric sector NOx emitters have used a cap-and-trade system to reduce sector-wide NOx emissions. The emissions that could be tapped from this type of program are likely the same that could otherwise be found from EGU displacement or replacement, but a trading program has the opportunity to tap the least cost reductions preferentially. Within the 34 states expected to be impacted by a 65 ppb standard, there are 778 coal-fired EGUs (235 GW) that emit about 1.2 million tons of NOx ever year,¹⁴ and another 2,796 EGUs (329 GW) that emit only 0.1 million tons every year. A market-based program might be expected to drive controls at some high emissions sources, and reduce the generation of other resources, while driving up the market share of low-emissions generation.
- **Accelerated Fleet Turnover:** Since 1992, National Low Emission Vehicle (NLEV) standards have driven down emissions from new cars and trucks sold in the US. One of the critical standards applied within the Tier 0, 1, 2 and now 3 programs have been the tracking of NOx emissions per mile driven, and the standard has been dropping rapidly. The standard reduced emissions from passenger cars from 1.0 g NOx/mile in 1997 to less than 0.03 g/mile by 2025. The substantially cleaner fleet will produce much fewer emissions, and help move dramatically towards meeting the lower emissions standard. However, natural vehicle turnover is relatively slow, and the fleet can be made cleaner faster through accelerated turnover programs, such as tax credits, purchase rebates, scrappage rebates, and other incentives like parking and HOV access.¹⁵ The cost effectiveness of these programs is highly debated.
- **National Energy Efficiency Standards:** The Department of Energy projects tens of thousands of tons in NOx reductions from federal energy efficiency measures proposed

¹¹ <http://www.utilitydive.com/news/snl-over-12000-mw-of-coal-plants-will-retire-in-2015/398232/>

¹² US EPA. 2004. Cap and Trade: Multi-State NOx Programs. www.epa.gov/captrade/documents/nox.pdf

¹³ US EPA. 2012. 2012 Progress Report: SO2 and NOx emissions, Compliance and Market Analyses.

¹⁴ 2014 Air Markets Program Data from US EPA, Clean Air Markets Division.

¹⁵ Rodier, C. S. Handy, and M. Boarnet. 2014. Policy Brief on the Impacts of Fleet Turnover Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions. California Air Resources Board. http://www.arb.ca.gov/cc/sb375/policies/flttrnovr/fleet_turnover_brief.pdf

or recently adopted for implementation over the next 15 years.¹⁶ The measures include stronger efficiency standards for appliances that either directly emit NO_x (e.g., gas furnaces and water heaters) or that draw power from electric generating plants that emit NO_x. EPA's RIA does not count emission reductions from efficiency measures as "known".¹⁷

2.2. The Need for Unknown Controls in the NERA Assessment

NERA claims the need for a quantity of unknown controls that far exceeds EPA's estimate, even after making assumptions that would have appeared to reduce the need for unknown controls. While EPA estimates a need for 750,000 tons of emissions reductions from unknown controls, NERA increases this number to 1,000,000 tons of reductions, and prices the reductions at an extraordinary cost.¹⁸ NERA's expansion of unknown control requirements and their high cost are the primary, indeed singular, driver of NERA's claim of extreme costs to meet a revised ozone standard.

It is difficult to assess why NERA chose a significantly higher quantity of unknown controls in part because NERA's assessment is poorly documented, uses values that are inconsistent with the RIA, and generally fails to reference back to the RIA. In addition, NERA's assessment appears to draw some values from the RIA for reference, and re-creates other values from NERA's proprietary black box NewERA model. The 60 ppb NERA analysis provides appendices and explanations for modifications performed by NERA. The later 65 ppb NERA analysis uses numbers that are inconsistent with EPA's, but fails to document how emissions reduction requirements are calculated in the alternative.

Given the opaqueness of NERA's analysis, it is not possible to reverse engineer that analysis. Nonetheless, we can trace through EPA's RIA and re-construct EPA's estimated NO_x emissions reduction requirements, and compare these against NERA's assumptions.

NERA makes some significant modifications to the RIA, few of which are quantitatively explained. Table 3 traces through the RIA and NERA's re-assessment as culled from an undocumented presentation.¹⁹

¹⁶ See, e.g., Department of Energy dockets including: Notice of Proposed Rulemaking (NOPR) Technical Support Document (TSD) at 13-10, EERE-2012-BT-STD-0047-0036; NOPR TSD at 13-9 (EERE-2014-BT-STD-0031-0027); NOPR TSD at 13-8 (EERE-2014-BT-STD-0036-0002); NOPR TSD at 13-9 (EERE-2013-BT-STD-0021-0012); NOPR TSD at 13-9 (EERE-2014-BT-STD-0005-0018); NOPR TSD at 13-8 (EERE-2013-BT-STD-0007-0027); NOPR TSD at 13-7 (EERE-2011-BT-STD-0031-0039); TSD at 15-11 to 15-13 (EERE-2007-BT-STD-0010-0053); TSD at 16-11 to 16-17 (EERE-2006-STD-0129-0170); TSD at 8-12 (EERE-2008-BT-STD-0013-0011); TSD at 13-7 (EERE-2010-BT-STD-0027-0108); TSD at 15-12 to 15-13 (EERE-2007-BT-STD-0007-0054).

¹⁷ EPA. 2014 RIA. Page 7-25. "The known control estimates for NO_x do not account for other forms of abatement, switching to lower emitting fuels or increasing energy efficiency, for example."

¹⁸ The 1,000,000 ton figure is not shown in NERA's 65 ppb study. Instead, that study shows an aggregate unknown control amount at 1.8 million tons (Figure S-2). However, in a separate presentation to EPA and TCEQ, NERA shows 800,000 tons of emissions reductions from EGU retirements and 1,000,000 tons of reductions from other unknown sources. See presentation in docket, EPA-HQ-OAR-2008-0699-4003.

¹⁹ "Assessing the Potential Economic Impacts of a 65 ppb Ozone NAAQS." Stakeholder presentation with US EPA, June 18, 2015. Page 7. Filed in docket as EPA-HQ-OAR-2008-0699-4003.



Table 3. Million tons of NOx Emissions, Regulatory Impact Assessment and NERA assessment

	EPA RIA (2025)	EPA source	NERA (2022)
Base Case Emissions	6.29	RIA Table 3-3	6.60
Reductions to CPP proposal	(0.31)*	CPP Proposal RIA	
Reductions to 75 ppb	(0.24)	RIA Table 3A-3	(0.30)
Baseline Emissions	5.75**		6.30
Known controls, minus EGU SCR	(0.92)	Ozone RIA docket	(0.80)
EGU SCR	(0.20)	Ozone RIA docket	
EGU closures			(0.80)
Unknown controls	(0.75)	RIA Table 4-10	(1.00)
Compliance Emissions	3.87**		3.70
<i>Total Reductions from Baseline</i>	<i>1.88**</i>		<i>2.60</i>

*calculated from CPP proposal RIA. Not reported in ozone RIA.

**estimated, not reported by EPA in ozone RIA.

EPA starts with “Base Case” emissions of 6.29 million tons. The 2014 RIA does not explicitly call out emissions reductions from the proposed Clean Power Plan. However, reviewing documents supporting the proposed CPP, we estimate there are about 309,000 tons of NOx emissions reduced in 2025 in the 34 states due to the proposed CPP.²⁰ EPA estimates that California and Texas would achieve another 236,000 tons of emissions reductions to meet the 75 ppb standard. EPA finds an additional 1,123,000 tons of emissions reductions from known controls in the 34 states.^{21, 22} In our table, we divide these into emissions reductions from SCRs at electric generating units (EGU) and other sources, for the purposes of comparing against NERA’s estimates. EPA ultimately estimates that states would need to obtain about 750,000 tons of incremental NOx emissions from unknown controls to meet the 65 ppb standard. If we were adding up the emissions reductions in the 34 affected states only, and applying those reductions to the base case emissions in 2025, we would find that those 34 states would (roughly) be in compliance at about 3.87 million tons of NOx emissions from all anthropogenic sources.²³

NERA departs from EPA’s estimates of emissions reduction requirements almost immediately. First, NERA uses a 2022 compliance deadline rather than EPA’s assumed 2025 RIA assessment year, an

²⁰ US EPA. June 2014. Regulatory Impact Analysis for the Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants. Data from IPM v. 5.13. Base Case (2025) and Option 1 (2030 compliance deadline, assessment year 2025). Specifically, see Parsed Files from IPM in CPP Proposal RIA Docket: EPA-HQ-OAR-2013-0602-0219 and EPA-HQ-OAR-2013-0602-0221.

²¹ See Ozone RIA docket supporting information, “Copy of 2014 O3 NAAQS RIA Control Strategy Results NOx Controls for 65 ppb Analysis Incremental to Baseline” filed in docket as EPA-HQ-OAR-2013-0169-0015. Accord RIA Table 4A-9.

²² This value is slightly more than the 1.11 million tons of known controls in the RIA main text (Table 4-10). Since the supplemental data is explicit on a per-control basis, we consider this the most reliable value in the RIA.

²³ This is a rough estimate only, and not provided by EPA. In reality, we cannot add up these emissions reductions linearly. EPA derives design values from the CPP proposal RIA. In doing so, it effectively takes into account emissions reductions in states that may not have ozone nonattainment areas but that reduce compliance obligations in states with ozone nonattainment areas. Therefore we cannot, strictly speaking, derive a “compliance emissions” value.

approach that NERA fails to justify (see discussion below and in Appendix A on this issue). The effect is to increase base case emissions substantially – by over 300,000 tons to 6.6 million tons. Presumably, the increase in NERA’s base case is their assumption that naturally occurring emissions reductions projected to occur by 2025 due to retirements and fleet turnover would no longer be available to serve state compliance needs.

Second, NERA completely disregards any benefit from the Clean Power Plan. NERA complains in other documentation that “including a proposed rule is ... inconsistent with [EPA’s] usual practice,”²⁴ and should therefore be rejected in full. In this case, the final Clean Power Plan became an on-the-books regulation during the tenure of the ozone RIA, and therefore the complaint is unwarranted. Indeed, since the revised ozone standard is not captured as a co-benefit of the Clean Power Plan RIA, excluding the CPP from the ozone standard assessment would fail completely to capture any of the joint benefit of these two closely tied regulations. By excluding the Clean Power Plan, NERA rejects 309,000 tons of emissions benefits from the proposed regulation.

Third, NERA removes over 100,000 tons of non-EGU known emissions controls, dropping from EPA’s 919,000 tons to 800,000 tons. NERA’s modification of EPA’s known control estimates is without explanation or documentation, and cannot be verified.

NERA assumes that a large number of EGUs would preferentially close, rather than install SCRs. Indeed, the organization assumes that nearly 20% of the existing coal fleet in 2025 (34 GW) would retire economically, rather than install SCRs. From this retirement (and presumably a decent number of conversions), NERA finds 800,000 tons of emissions reductions, in excess of EPA’s 205,000 tons of reductions from the EGU fleet.²⁵ It is not clear what criteria are used by NERA to choose to retire a unit rather than retrofit, what replaces retired units (e.g. low emissions resources or renewable energy?), and NERA’s cost of replacement. We only learn that NERA contends “the majority of the NOX emission reductions associated with the EGU closures cost an average of about \$16,000 per ton, and range well above \$30,000 per ton in some states.”²⁶ Economic retirements result when a capital investment is more expensive (over time) than simply retiring a unit and replacing its capacity and energy. By definition, an economic retirement only occurs when the cost of replacement is lower than the cost of the emissions control (again, over time).

NERA’s costs per ton for retiring units are very high and difficult to replicate without extremely high estimates for the costs of SCRs and pessimistic assumptions about their efficacy.²⁷

²⁴ NERA. 2015. EPA Regulatory Impact Analysis of Proposed Federal Ozone Standard: Potential Concerns Related to EPA Compliance Cost Estimates

²⁵ See ozone RIA docket supporting information in EPA-HQ-OAR-2013-0169-0015. Emissions reductions in 2025, filtered for EGU SCRs only.

²⁶ NERA, 2015. Page 9, footnote 10.

²⁷ Take, for example, a coal unit (75% capacity factor, 10.5 MMBtu/MWh heat rate) with a median low NOx burner (LNB) and emissions rate of 0.23 lbs/MMBtu. If we assume a BACT SCR (0.07 lbs/MMBtu) costs \$300/kW and incurs \$20/kW-yr of fixed

After having taken into account all other reductions from known controls, NERA assumes that achieving compliance requires an additional 1,000,000 tons of unknown control. This value is well in excess of EPA's 750,000 ton estimate.

For the above reasons as well as those discussed below, NERA's estimate of NOx reductions needed from unknown controls is simply not credible. In the next section, we develop a more realistic assessment of the reductions needed from unknown controls.

2.3. Synapse Re-Assessment of the Need for Unknown Controls

The EPA RIA started from a baseline level of emissions in 2025 based on the proposed Clean Power Plan. On August 3, 2015, EPA released the final CPP and associated CPP RIA.²⁸ As in the proposed CPP RIA, EPA released model output files supporting the cost assessment, including estimates of future generation and emissions by EGU.²⁹ We pulled files for the base case run³⁰ (i.e. in absence of the CPP) and the mass-based compliance model run.³¹ The CPP final RIA model runs identify units, but do not provide EGU names or readily accessible identification information. Therefore, we associated EPA's model regions with affected states and identified affected EGUs through this association.

Echoing EPA's ozone RIA, we assessed emissions in 2025 after the application of the final CPP. Unlike EPA's ozone RIA, however, we reviewed potential cost-effective emissions reductions that could be realized through more stringent stack controls and EGU retirements.

There are several notable changes that are incurred by starting with the final CPP rather than the proposed CPP (as in EPA's ozone RIA) or no CPP (as in NERA's assessment):

- EPA's modeling runs from 2015 estimate lower base case emissions in 2025 than in the 2014 Ozone RIA. EPA has historically underestimated cost-effective EGU retirements. Since 2014, additional coal-fired EGUs have announced their intent to retire. Thus, EPA's most recent estimate of base case emissions in 2025 likely reflects announced changes in the electric sector and the increasingly poor outlook for coal-fired generators due to

costs, the retrofit will accomplish reductions at about \$8,500/ton. To reach \$30,000 per ton we could assume that retrofits cost 3.5x more than our \$300/kW estimate or that the SCR is particularly ineffective (only reduces emissions to the rate of the least effective SCRs at 0.19 lbs/MMBtu).

²⁸ EPA, 2015. Regulatory Impact Analysis for the Clean Power Plan Final Rule. <http://www.epa.gov/airquality/cpp/cpp-final-rule-ria.pdf>

²⁹ See <http://www.epa.gov/powersectormodeling/cleanpowerplan.html>. See .RPE files associated with each modeling run.

³⁰ Base Case: http://www.epa.gov/airmarkets/documents/ipm/Base_Case.zip

³¹ Mass-Based Compliance with CPP: http://www.epa.gov/airmarkets/documents/ipm/Mass_Based.zip



declining power prices and sales. Overall, EGUs in the final CPP base case emit 61,000 tons NOx less than in the proposed CPP base case in 2025.

- The final CPP accomplishes only about 60% of the NOx emissions reductions of the proposed CPP in 2025. While the proposed CPP reduced NOx emissions in the 34 affected states by 309,000 tons in 2025, the final CPP reduces NOx emissions by about 179,000 tons in 2025.

For purposes of the analysis, we took the same approach as NERA and assumed that compliance with the ozone standard would occur at approximately the same aggregate NOx emissions as reflected by the NOx emission reductions EPA relied on in the RIA. Thus, we echo EPA's approximate level of compliance emissions at 3.87 million tons in 2025.

We agreed with NERA that cost effective unit retirements should be considered in assessing the cost of attaining a stricter ozone standard. History demonstrates a robust pattern of merchant generators and utilities that make rational decisions to retire aging infrastructure faced with compliance costs and falling value. Reviewing supporting documentation behind EPA's 2014 RIA, we noted that EPA looks to apply SCRs to 145 coal-fired EGUs;³² there are over 400 coal-fired EGUs in the affected states, over half of which have NOx emissions rates in excess of the worst performing controlled EGUs.³³ It is unclear how EPA chose the units that received SCR controls. While most of the EGU selected by EPA in the RIA have no or sub-standard controls, this was not universally the case. EPA did not select at least 65 coal-fired EGUs with sub-standard controls. Synapse re-calculated possible emissions controls, correcting EPA's RIA assumptions to capture emission controls and retirements for coal-fired EGUs.

Starting with 2025 EGU emissions in the mass-based compliance version of the final CPP RIA, we identified 412 coal-fired EGUs in the 34 affected states, representing 177 GW of capacity and responsible for 960,000 tons of NOx in 2025 – after the CPP. Of these units, we identified a cohort of 181 EGUs with emissions rates in excess of 0.17 lbs NOx/MMBtu – higher than the poorest performing quartile of SCR-controlled coal-fired units. This cohort represented 54 GW of generation and is estimated to produce about 450,000 tons of NOx in 2025. Of those units, we assumed that larger, high performance units (250 MW and above, and 50% capacity factor or above) would preferentially install SCRs to meet a Best Available Control Technology (BACT) level of 0.07 lbs NOx/MMBtu.³⁴ Low performance and smaller units were assumed to preferentially retire. As a conservative estimate, retired

³² Updated 2014 O3 NAAQS RIA Control Strategy Results - NOx Controls for 65 ppb Analysis Incremental to Baseline.xlsx

³³ 210 coal-fired EGUs in the 34 affected states are estimated to have NOx emissions rates in 2025 in excess of 0.17 lbs NOx/MMBtu. In 2014, the bottom quartile of SCR-controlled EGUs emitted at 0.17 lbs/MMBtu or higher. Source: 2014 Air Markets Program Data (AMPD) from EPA Clean Air Markets Division.

³⁴ We chose this level of BACT on the basis of the top quartile of emissions from highly controlled coal-fired units (i.e. units with LNB and SCRs), and recent Regional Haze Federal Implementation Plan requirements in western states.



units were replaced in kind with SCR-controlled natural gas units³⁵ producing the same amount of generation.³⁶

Ultimately, this scenario leads to 360,000 tons of NOx emissions reductions across the 34 states, 241,000 tons from retrofit units, 119,000 tons from replaced units. This total reduction is well in excess of EPA’s estimated 211,000 tons of reductions from EGUs.³⁷

Taking into account these reductions, we are now left with 663,000 tons of emissions required from unknown sources, a far cry from NERA’s 1,000,000 tons of unknown reductions.

Table 4. Million tons of NOx Emissions, RIA, NERA, and Synapse Re-assessment

	EPA RIA (2025)	NERA (2022)	Synapse (2025)
Base Case Emissions	6.29	6.60	6.29
Reductions to CPP proposal	(0.31)		
Reductions to CPP final			(0.18)
Reductions to 75 ppb	(0.24)	(0.30)	(0.24)
Updated 2015 Base Case			(0.06)
Baseline Emissions	5.75	6.30	5.81
Known controls, minus EGU SCR	(0.92)	(0.80)	(0.92)
EGU SCR	(0.20)		(0.24)
EGU closures		(0.80)	(0.12)
Unknown controls	(0.75)	(1.00)	(0.66)
Compliance Emissions	3.87	3.70	3.87
<i>Total Reductions from Baseline</i>	<i>1.88</i>	<i>2.60</i>	<i>1.94</i>

For all of the above reasons, it is our assessment that NERA’s estimate for emission reductions needed from unknown controls are sharply inflated. This overestimate is the first reason that NERA finds a grossly inflated cost for compliance with the proposed ozone standard at 65 ppb.

³⁵ Median emissions rate in 2014 for SCR controlled gas units = 0.02 lbs NOx/MMBtu. Source: 2014 Air Markets Program Dataset from EPA Clean Air Markets Division. Assumed heat rate for new gas of 7.5 MMBtu/MWh.

³⁶ This report does not advocate the replacement of retired coal units with natural gas (as opposed to renewable energy sources and/or energy conservation). The assumption here is simply a conservative, readily understood estimate for analysis purposes.

³⁷ Note: we can attempt to match NERA’s estimate by assigning a NOx rate threshold of 0.11, and targeting all units smaller than 270 MW. This produces 34 GW of retirements (similar to NERA’s estimate), and 761,000 tons of reductions. Most of these reductions are generated through the installation of SCRs, rather than retirements. In fact, we can generate 665,600 tons of NOx reductions simply by installing state-of-the-art SCRs on all units with emissions rates above 0.15 lbs NOx/MWh and not requiring any coal unit retirements. We believe, however, that smaller units are likely to be found non-economic, and would therefore be replaced economically.



3. UNKNOWN CONTROL COSTS

3.1. The Cost of Unknown Controls in the RIA

In the RIA, EPA uses a cost for unknown controls of about \$15,000/ton, setting the limit at the upper end of the cost for known controls (primarily SCRs on units with little operation). EPA explains that this price is conservative relative to NOx reductions made available through previous regulations and NOx offset prices in highly NOx limited regions (i.e. the LA basin). In addition, EPA notes that all other controls examined were available at an average cost of \$3,400/ton.³⁸

EPA's RIA is not meant to be a comprehensive, multi-state implementation plan. It does not substitute for states taking careful inventory of their own emissions, seeking opportunities for cost effective reductions, and implementing those reductions efficiently. And while the RIA captures 79,000 separate NOx reduction opportunities, it is still meant to capture a rough sense of the overall reductions available at a certain cost. It would be reasonable to assume that there are significant additional NOx reduction opportunities available beyond those strictly captured by the RIA. Historically, states, regional air agencies, regulated entities, and EPA have regularly developed new and creative ways to reduce air pollution that have proven cost-effective. Indeed, the RIA itself so finds.³⁹

Further, as explained in Appendix A below, if a state believes the costs of complying with the standard by the designated compliance deadline are too great, an area has the option of extending its compliance deadline through a voluntary reclassification. Rather than assume an area would be required to undertake exorbitantly costly actions in order to comply by 2022 or even 2025, it is rational to assume that areas in this situation would instead choose to reclassify.

3.2. The Cost of Unknown Controls in NERA's Analysis

NERA disagrees with EPA's unknown control costs, and instead opts for a marginal cost derived from a different source.⁴⁰ NERA's "evidence-based" method relies on a single data point – the estimated NOx emissions benefit of scrapping older vehicles under the Car Allowance Rebate System (CARS). Commonly

³⁸ In the RIA, there are exactly 41 known controls in excess of \$15,000/ton. Each one represents the application of SCRs at EGU with particularly low generation in EPA's base data year. These units therefore emitted very little NOx in the first place, and thus the high capital cost for SCRs achieved relatively little NOx reduction at these selected cases (25,000 tons at these units). This is not an indictment against SCRs: controls on another 105 units achieve 179,000 tons of emissions reductions at an average cost of \$6,400/ton.

³⁹ EPA. 2014 RIA. 7-20 through 7-22.

⁴⁰ It is notable that EPA spends 20 pages exploring different types of assumptions for unknown costs, including reviews of historic emissions reduction costs from five different regulations from 1997 to 2008, market-based offset prices in NOx constrained regions, the known controls captured within the RIA, and learning curves for technology innovation. Nonetheless, NERA insists that their method is "evidence-based" (a term which they use 12 times in the core report, or once every six pages), wrongly implying that EPA's is not. In reality, EPA's approach is based on historical evidence that is far more credible than NERA's reliance on a single hypothetical cash-for-clunkers program.

known as “cash for clunkers,” the CARS program was a two-month, \$3 billion program designed to stimulate car sales and remove older vehicles from the road. The CARS program had two primary foci: (a) provide economic stimulus via car sales, and (b) improve the gas mileage of the existing fleet.⁴¹ The program had additional ancillary emissions benefits: new cars are subject to more stringent environmental regulations and thus are significantly cleaner.

Several papers have sought to estimate the emissions benefit of the CARS program, focusing in particular on emissions of CO₂. NERA chose the earlier of these papers (Knittel, 2009), and used a simplified framework presented in the paper’s introduction to work up a rough “cost” for NO_x emission reductions from the program. In doing so, NERA generates a cost of about \$500,000 per ton of NO_x, an extraordinary cost relative to any other estimate.

NERA effectively assumes that (a) the \$500,000/ton NO_x is the marginal cost of abatement – the most expensive thing that one could do to access NO_x emissions reductions, (b) that a similar program on a massive scale would yield 75% NO_x emissions reductions (or 50% of the entire car and light duty truck fleet), and (c) that any emissions reductions below that ambitious (and expensive) level would be incrementally less expensive, along the same curve.

The result of NERA’s assessment is shown in Figure 1, below.⁴² The structure follows the cost curve shown by NERA in a presentation to EPA (see Figure 2b).

- The dark blue section under the curve represents the total cost of EPA’s known controls, with the exception of controls on electric generating units. NERA estimates 800,000 tons of reductions at a total cost of \$1.6 billion.
- The light blue section is a rough estimate of NERA’s cost of controls for EGU retirements and retrofits, covering another 800,000 tons. NERA states that these costs average about \$16,000/ton and rise as high as \$30,000/ton. NERA does not show the cost of this segment, but we would estimate it at about \$17.6 billion.
- The orange section is an estimate of NERA’s unknown costs, rising from the highest cost EGU retirement or retrofit to the notional point at \$500,000/ton. While the curve rises towards this marginal cost, it does not reach it, stopping instead at \$140,000/ton, a point marked by 2.6 million tons of reductions.⁴³ NERA erroneously estimates the cost

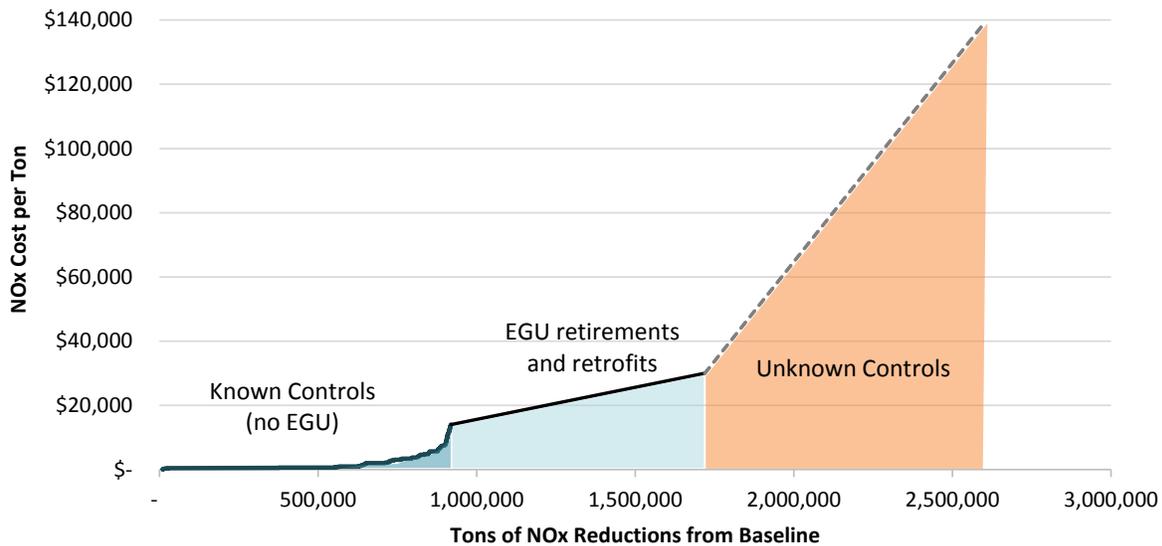
⁴¹ Gayer, T. and E. Parker. 2013. Cash for Clunkers: An Evaluation of the Car Allowance Rebate System. [http://www.brookings.edu/~media/research/files/papers/2013/10/cash-for-clunkers-evaluation-gayer/cash for clunkers evaluation paper gayer.pdf](http://www.brookings.edu/~media/research/files/papers/2013/10/cash-for-clunkers-evaluation-gayer/cash%20for%20clunkers%20evaluation%20paper%20gayer.pdf)

⁴² Please note that the figure here is representational only. NERA’s assessment of coal plant closure costs and emissions reductions are not portrayed because NERA provides little information on the shape of the cost curve for plant closures. Based on NERA’s descriptions, the unknown cost curve likely starts slightly to the right, and is slightly steeper. In addition, it is unclear if NERA’s cost curve in the 65 ppb study are reductions relative to the 60 or 65 ppb base case emissions. NERA’s math is not laid out clearly in any documentation, and cannot be directly replicated.

⁴³ To reach this point we follow NERA’s convoluted math, drawing a line from 1.6 million tons of reduction to 3.48 million tons (a 40% reduction beyond EGU controls), reaching from \$30,000/ton (the highest cost of EGU controls in NERA’s study) to

of unknown controls here at \$153 billion.⁴⁴ Correcting NERA’s math, we find they should have indicated it cost approximately \$84.5 billion. We explain this error later in this document.

Figure 1. Cost curve for known NOx emissions reductions from EPA (solid line) with NERA marginal cost curve



Regardless of the error, it becomes readily apparent that the vast majority of the costs assumed by NERA are driven by the assumption that the marginal cost of abatement for NOx is driven by the extremely high cost of the CARS program. In fact, NERA states that the orange area of the curve in the “unknown controls” region is over ten times larger than the combined known and unknown controls regions of EPA’s assessment. The massive wedge of costs is driven by a single endpoint: NERA’s assumed cost of marginal abatement at \$500,000/ton.

NERA’s cost estimate for the 65 ppb ozone standard is driven almost exclusively by the cost of unknown controls.

\$235,000/ton (a point noted in NERA’s presentation to EPA). At 2.6 million tons of reductions, the marginal cost is estimated at \$140,000/ton.

⁴⁴ “Assessing the Potential Economic Impacts of a 65 ppb Ozone NAAQS.” Stakeholder presentation with US EPA, June 18, 2015. Page 7. Filed in docket as EPA-HQ-OAR-2008-0699-4003.

3.3. Assessing NERA's Cost of Unknown Controls

Although car scrappage programs can be a strategy for reducing NOx emissions, it is simply indefensible to claim – as NERA does – that such programs should be the **only** basis for assessing the marginal cost of unknown controls. Moreover, NERA makes several key assumptions that are fundamentally flawed.

Other Studies Imply Lower Costs for Emissions Reductions from Car Scrappage

NERA selectively chose one paper to represent the marginal cost of NOx emissions abatement, a paper which acknowledges that a variety of assumptions guide the final outcome. In 2012, another analysis of the emissions benefit of the CARS program was produced by Resources for the Future,⁴⁵ using a different methodology and assumption set. While neither paper reviewed the efficacy of the program on NOx emissions, both papers reviewed the implied cost of carbon reductions from the CARS paper. Knittel (2009)⁴⁶ cited by NERA estimates the implied cost of carbon reductions at about \$400/ton CO₂,⁴⁷ while Li, Linn & Spiller (2012) find a far lower cost of carbon between \$105-\$281/ton CO₂.⁴⁸ Assuming that NOx and CO₂ benefits from a scrappage program scale linearly, the Knittel estimate is **2-4 times higher** than Li, Linn & Spiller. NERA's selective use of one study inappropriately drives their high cost estimate.

NERA's Marginal Cost is Subject to Significant Uncertainty

The Knittel paper and NERA assume a four year acceleration for car retirements under a rebate program; changing this value significantly impacts the cost effectiveness of the program. For example a six year acceleration would drop the cost by 30%. Second, the value assumes that, in 2022, cars from 2007 would be scrapped, rather than cars of any earlier vintage. Car lifespans, scrappage rates, vehicle miles traveled (VMT) per year, VMT over a vehicle lifespan, and emissions rates for new and aging cars are all probabilistic functions, and cannot be classified into NERA's distilled point estimates.⁴⁹ For example, NERA assumes that cars produced in 2007 have an emissions rate of 0.19 g NOx/mile. The fleet of today's cars, however, has a much higher emissions rate. In 2008, the total passenger vehicle fleet had an emissions rate of 0.63 g NOx/mile.⁵⁰ To the extent that a car scrappage program in 2022 targets

⁴⁵ Li, S., J. Linn, & E. Spiller. 2010. Evaluating Cash for Clunkers. Resources for the Future Discussion Paper. Resources for the Future.

⁴⁶ Knittel, C. 2009. The Implied Cost of Carbon Dioxide under the Cash for Clunkers Program. University of California, Davis.

⁴⁷ Base case, no elasticity. Four year scrappage acceleration.

⁴⁸ Panels 1 & 2 (full sample), lifetime VMT and adjusted VMT, no rebound effect, no co-benefit.

⁴⁹ Specific assumptions are critical in this analysis. NERA adopts an assumption of a vehicle life of 200,000 miles. If total VMT were assumed at 250,000 miles instead, the cost of emissions reductions drops by 50%. Similarly, if annual VMT drops to 10,000 from 12,000 miles per year, the cost of emissions reductions drops by 33%. The emissions rate of old vehicles, new replacement vehicles, and the rebate offered all impact the outcome substantially.

⁵⁰ EPA. 2008. Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks. EPA420-F-08-024



a wide vintage of cars, it could produce far greater emissions reductions. Finally, the Cash for Clunkers program may have offered a rebate far in excess of what was required to actually accomplish fleet turnover, which means that derived emissions costs are over-priced. Initially, the program had a \$1 billion budget, anticipated to be consumed over a five month period. It was consumed in less than a month. The office charged with the program received far more participation than anticipated, and the program ultimately consumed its full \$3 billion budget in just two months.⁵¹ This evidence suggests that the rebate could have been substantially smaller and accomplished the same emissions benefit.

Car Scrappage Programs can be Tuned for Emissions Reductions

NERA assumes a cost of NO_x consistent with one estimate of the cost of a car scrapping program. That program offered rebates to replace cars with poor miles-per-gallon (MPG) ratings with new cars. The program, however, was not designed to reduce NO_x specifically. In contrast, California's Consumer Assistance Program (CAP) offers a rebate for older vehicles that fail emissions testing, specifically targeting high emissions vehicles.⁵² Similarly, San Joaquin Valley Air District offers rebates to scrap cars that fail emissions testing, offering increasing rebates for lower emissions vehicles.⁵³ While these programs have not been evaluated *post-hoc* for cost effectiveness yet, it is likely that they will achieve NO_x reductions at a much lower cost than the CARS program, because they are designed specifically to reduce emissions.

Alternative NO_x Offset Prices are Significantly Lower than NERA's Marginal Cost

Several air districts in the US have had chronic excessive ozone, and have required NO_x offset programs to meet current standards. It is notable that these regions have extreme ozone stress; the offset program is required to ensure that new sources do not lead to additional deterioration. EPA characterizes four of these areas that have used a NO_x offset program in the past. NO_x offsets vary widely in cost, but a 2014 report from the California South Coast air district - which has some of the most expensive offset costs in the nation - finds average NO_x offset costs of \$63,000/ton.⁵⁴ EPA's RIA estimates an average cost of \$15,000 per ton for NO_x offsets. These figures are well below NERA's marginal cost.

For all of the above reasons, it is our assessment that NERA's estimate for the cost of unknown controls is grossly excessive. NERA's reliance on "cash for clunkers" as the sole basis for assessing unknown control costs, and its selective use of a single study to mischaracterize the marginal cost of NO_x

⁵¹ Gayer, T. E. Parker. 2013. Cash for Clunkers: An Evaluation of the Car Allowance Rebate System. Brookings Institution.

⁵² http://www.smogtips.com/vehicle_buy_back.cfm

⁵³ <http://valleyair.org/grants/pass.htm>

⁵⁴ South Coast Air Quality Management District. 2014. Annual Publication of Emission Reduction Credit Transactions For Calendar Year 2014. <http://www.aqmd.gov/docs/default-source/permitting/ercs/2014/h-s-code-40709-5-cy-2014-report.pdf>.



abatement under such a program is the second reason for NERA’s extreme overstatement of compliance costs for an ozone standard at 65 ppb.

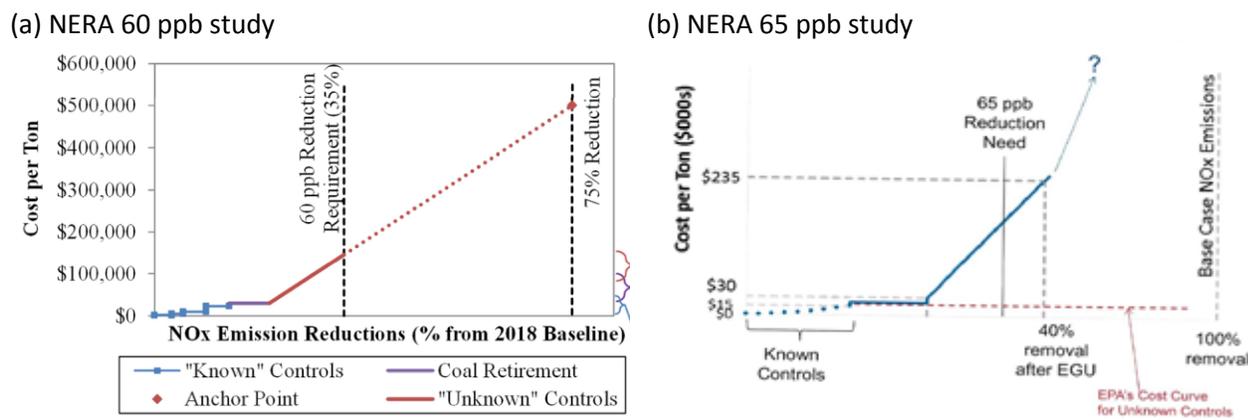
3.4. Down the Rabbit Hole: Tracing NERA’s Costs for Controls

One important element in producing data or critiques for the public record is ensuring that studies are well documented, fully supported and appropriately transparent. NERA fails on all three of these counts, leaving even well informed researchers to guess how the organization even arrived at basic figures.

NERA’s Marginal Cost for Unknown Controls is Inconsistent Across NERA Studies

NERA oft cites a \$500,000/ton NOx marginal cost of abatement widely, but nowhere in either the 60 or 65 ppb studies does NERA show the definitive emissions reduction level associated with this dollar figure. Deep in the appendix (C-11), the 60 ppb study indicates that \$500,000/ton corresponds to a 75% emissions reduction from a baseline level, which suggests 7.3 million tons of reductions are available below that cost. Of course, neither the 60 nor the 65 ppb standards would require 75% emissions reductions, so this value does not get used directly. Instead, NERA assumes a requirement of 3.9 million tons of reductions, from which we might deduce a marginal cost of about \$197,000/ton NOx.⁵⁵ This value is not stated in the study. Rather, the only form of confirmation is a figure in the paper with a 60 ppb line that appears to cross the supply curve at about \$150,000/ton NOx (see Figure 2a, below). To add to the confusion, this line reads “35% reduction,” which is inconsistent with NERA’s own assumptions about the amount of reduction required to reach 60 ppb (a 40% reduction).⁵⁶

Figure 2. Cost curves for NOx reductions from NERA’s ozone studies.



⁵⁵ To derive this value, we start with NERA’s assumed \$500,000/ton figure at 75% reduction, or 7.28 million tons reduced from 9.70 million tons baseline (see NERA 2014, Table B-2). NERA assumes that known controls and “cheap” coal scrappage can obtain another 1.98 million tons of reductions (Table C-5/6), and unknown reductions thereafter start at \$30,000/ton. Connecting the line from 1.98 million tons of reduction at \$30,000/ton to 7.28 million tons of reduction at \$500,000/ton, we arrive at \$197,000/ton at the 60 PPB “total reduction” of 3.87 million tons (Table C-5).

⁵⁶ 3.87 million tons of reduction (Table C-5) over the 9.70 million tons baseline = 40% reduction.

In the updated 65 ppb study, NERA skips these details altogether, even though there have been substantial changes in the data from which NERA's study is derived. First, the base case has changed with updated numbers from EPA; second, NERA assumes a new compliance deadline (2022, instead of 2018); and third, the required reductions have changed to the 65 ppb requirement. In fact, to even evaluate NERA's cost curve, we had to review separate presentations given by NERA to EPA and TCEQ.

In a June presentation to EPA,⁵⁷ NERA shows a cost curve with \$235,000/ton pegged to a 40% reduction "removal after EGU" (see Figure 2b, above). The 40% reduction appears to be legacy from the 60 ppb study (as noted above). The cost of the 40% reduction does not line up with NERA's 60 ppb cost curve from NERA's earlier study. In fact, following NERA's 60 ppb cost curve methodology, we estimate that NERA has inflated this marginal cost by nearly 45%.⁵⁸ The cost NERA states has no explanation and is impossible to derive.

Of course in the 65 ppb study, the baseline has changed, reviewing 2022 instead of 2018, and the amount of known controls have also changed. It is nearly impossible to tell how to align NERA's assumptions in the 60 and 65 studies, but the organization seems to envision that its numbers should simply be trusted, despite clear mistakes even within public presentations.

NERA's Total Cost of Controls is Erroneously Derived

As shown above, NERA provided scant information in the 65 PPB study about the shape of their NOx supply curve, leaving out essential pieces of information such as the x-axis labels in the graph (see Figure 2a&b). The curve in Figure 2b, however, is clear enough to show that the wedge of unknown controls starts at a cost of \$30,000 and rises to a cost somewhere below \$235,000. We know that the length along the bottom of their wedge is 1,000,000 tons (the amount of unknown controls required). The wedge presumably starts at 1.6 million tons (all of NERA's known controls beyond the baseline) and ends at 2.6 million tons (all of NERA's known and unknown control reductions beyond the baseline).

Finding the marginal cost of emissions reductions to get to 65 ppb requires connecting the points between the bottom and top of the known cost curve,⁵⁹ and interpolating between. We find that NERA's marginal cost is about \$139,000/ton. The area of NERA's unknown controls, therefore, should be about \$84.5 billion. NERA, however, presents a very different number to EPA and TCEQ: \$153 billion.

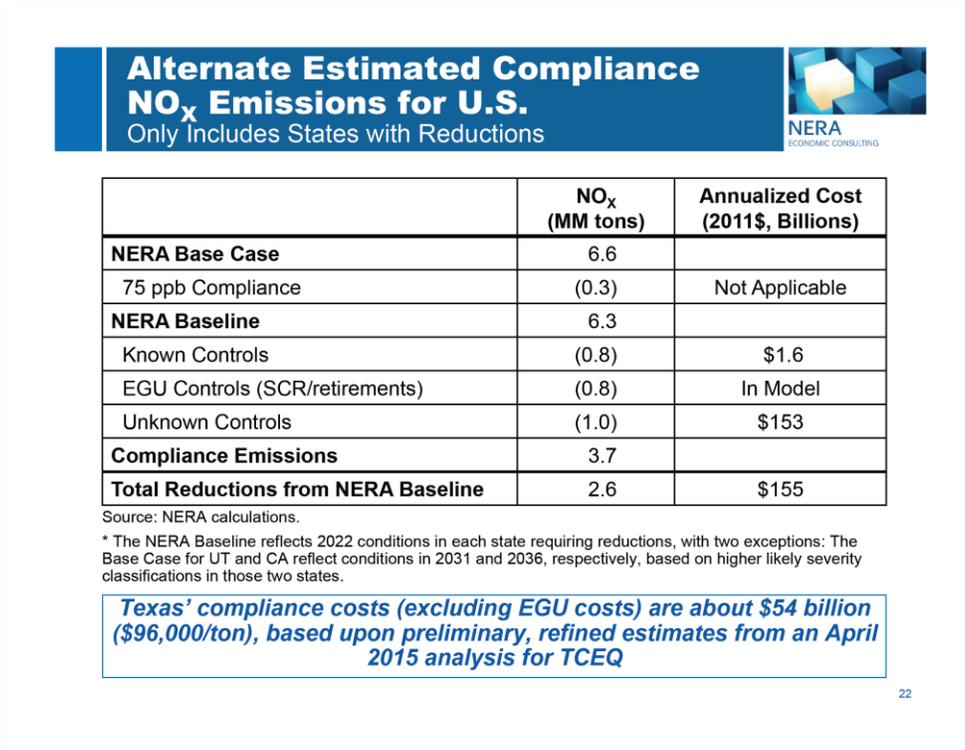
⁵⁷ "Assessing the Potential Economic Impacts of a 65 ppb Ozone NAAQS." Stakeholder presentation with US EPA, June 18, 2015. Page 8. Filed in docket as EPA-HQ-OAR-2008-0699-4003.

⁵⁸ We would expect a 40% reduction to mean 3.48 million tons of reductions from the 6.3 million ton baseline. Reviewing Figure 2b, the y-axis is at zero tons of reductions from the baseline. Known controls account for 0.8 million tons, EGU controls account for another 0.8 million tons (1.6 million). Of the remaining 4.7 million tons to reach zero emissions, 40% is 1.88 million tons. Therefore, the "40% reduction after EGU" can be reasonably interpreted as 1.6+1.88, or 3.48 million tons. Following the methodology of footnote 55, this implies a cost of \$163,000/ton, not \$235,000/ton.

⁵⁹ Bottom of the unknown cost curve: \$30,000/ton at 1.6 million tons. Top of the unknown cost curve: \$235,000/ton at 3.48 million tons.

^{60,61} (see Figure 3, below). In fact, of NERA’s \$155 billion annual cost of compliance, \$153 billion (or close to 99%) is driven by NERA’s assumed cost of unknown controls.

Figure 3. Slide from NERA presentation given at TCEQ.⁶²



This \$153 billion figure, presented to EPA and TCEQ, is curiously absent from NERA’s formal paper provided to NAM. In fact, the NAM paper shows annual costs that never exceed \$115 billion per year (in 2014 dollars) (see Figure 4) NERA fails to explain this glaring inconsistency.⁶³

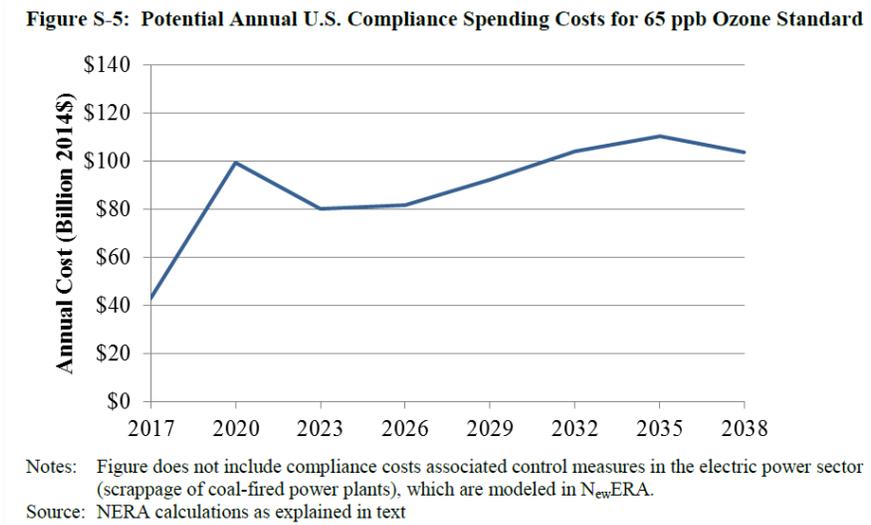
⁶⁰ “Assessing the Potential Economic Impacts of a 65 ppb Ozone NAAQS.” Stakeholder presentation with US EPA, June 18, 2015. Page 7. Filed in docket as EPA-HQ-OAR-2008-0699-4003.

⁶¹ Bloomberg, S. NERA. 2015. *Assessing the Potential Economic and Distributional Impacts of a Tighter Ozone NAAQS*. TCEQ Independent Workshop on Ozone NAAQS Science and Policy. Austin, TX April 7-9, 2015

⁶² Bloomberg, S. NERA. 2015. *Assessing the Potential Economic and Distributional Impacts of a Tighter Ozone NAAQS*. TCEQ Independent Workshop on Ozone NAAQS Science and Policy. Austin, TX April 7-9, 2015

⁶³ The paper’s slide explains that it does not include control measures in the electric sector (scrappage of coal-fired plants), but these are also excluded from the TCEQ slide deck.

Figure 4. Figure from NERA's 65 ppb study showing annual compliance costs.



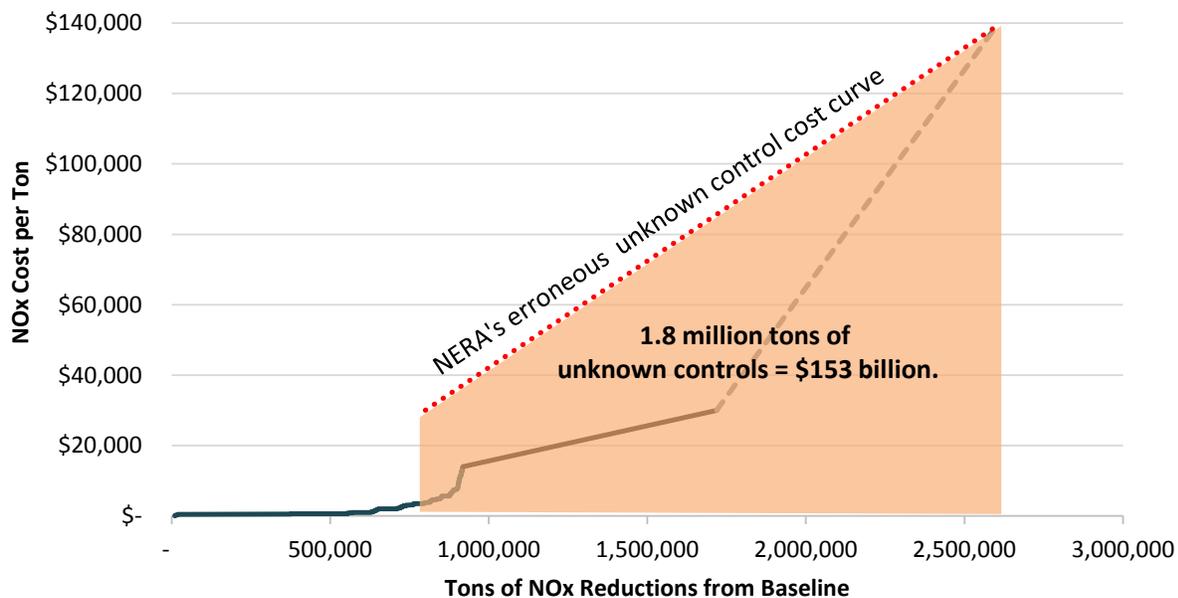
How might NERA have come up with \$153 billion in annual costs? Through a simple mistake with extraordinary consequences.

As noted previously, NERA's 65 ppb study shows total unknown control requirements at 1.8 million tons (Figure S-2), but NERA ultimately attributes 800,000 tons of these reductions to coal-fired retirements and retrofits.⁶⁴ These closures and retrofits have explicit individual unit costs in NERA's assessment and are should therefore not be a part of the unknown control cost curve. In fact, NERA's illustrative cost curve shown to EPA is careful to differentiate the EGU controls from the unknown costs (see Figure 2b).

However, what if we calculate the area of the unknown cost wedge, but assume that it is 1.8 million tons long instead of just 1 million tons? We arrive at \$152 billion in unknown control costs – within spitting distance of NERA's derivation. Figure 5, below, shows NERA's erroneous cost curve for unknown costs, replacing the known cost of EGU controls and retrofits with generic and notional unknown costs, at a marginal price far in excess of reason.

⁶⁴ "Assessing the Potential Economic Impacts of a 65 ppb Ozone NAAQS." Stakeholder presentation with US EPA, June 18, 2015. Page 7. Filed in docket as EPA-HQ-OAR-2008-0699-4003.

Figure 5. NERA's erroneous cost curve for unknown controls, accounting for \$153 billion in costs.



NERA's derivation is wrong, double counts coal unit retirement and retrofit costs, and assigns arbitrarily high costs based on a notional curve to knowable control costs. NERA's total costs appear to be based simply on **bad math**.

NERA's Cost of Coal Retirement is Unfounded and Unsupported

NERA's re-evaluation of the RIA includes a substantial change not contemplated by EPA: retiring non-economic coal-fired units that would otherwise install SCRs. NERA provides very little information on how this decision is made, or how much retirements (or SCRs) cost. In the 60 ppb study, NERA indicates that reductions from retiring coal-fired units "will cost an average of approximately \$31,000/ton, but with costs ranging up to about \$180,000/ton among states."⁶⁵ Just seven months later, NERA's math for the 65 ppb study has changed dramatically where they now "estimate that the majority of the NOX emission reductions associated with the EGU closures cost an average of about \$16,000 per ton, and range well above \$30,000 per ton in some states." NERA explains that the decision to retire or retrofit a coal unit is a decision made by their NewERA model (endogenous retirements).

We can check NERA's math to some extent by reverse engineering a quick, conservative exercise. First, we assume that if a unit can obtain reductions through retirement for less than installing an SCR, it will do so. Therefore, the cost of control for an SCR is the cap on the implied cost of emissions from EGUs. Replacing coal-fired power with either controlled gas or renewable energy when cost effective will result

⁶⁵ NERA 2014, S-9.

in lower emissions costs, not higher costs. Second, we can check NERA's math. The median emissions rate for a semi-controlled coal unit (i.e. a low-NOx burner) is 0.23 lbs/MMBtu; the median emissions rate for an SCR-controlled unit is 0.09 lbs/MMBtu.⁶⁶ NERA does not provide its assumed costs for SCRs or unit replacement (or any other information about their model assumptions), so we turn to other sources instead. Assuming a (high) capital cost for SCR of \$400/kW and O&M costs of approximately \$20/kW-yr,⁶⁷ we would estimate that emissions reductions cost about \$11,000/ton NOx for a 75% capacity factor unit,⁶⁸ still below NERA's costs. The capital costs cited here, however, are for an SCR with 93% control efficiency, which is closer to BACT rates of 0.07 lbs NOx/MMBtu. In addition, other sources cite lower cost SCRs, ranging from \$180/kW for a large EGU to \$420/kW for a very small EGU.⁶⁹ Even at a mid-range capital cost of \$250/kW and a BACT emissions rate, the implied cost of emissions are \$7,600/ton - less than half of NERA's revised estimates. In contrast, NERA's 60 ppb study estimated costs of \$180,000/ton: It is hard to imagine how NERA arrived at a figure of this magnitude.

4. SYNAPSE RE-ANALYSIS OF RIA COSTS FOR UNKNOWN CONTROLS

We strongly disagree with many of NERA's assumptions driving the RIA costs. In particular, we believe that NERA inappropriately adjusted expected reductions in the base case, increased the amount of unknown controls required to reach compliance, used an inflated cost for unknown controls, likely overestimated the costs of controls and/or retirements at existing coal-fired units, and increased baseline emissions by accelerating the compliance schedule. However, we do agree with NERA that economic coal retirements should be captured in an economic assessment of a regulation. We reconstructed portions of NERA's assessment to generate what we believe are corrected costs, leaving intact some of NERA's assumptions. Ultimately, our outcome is significantly different than NERA's.

4.1. Method

Starting with EPA's estimates of Base Case NOx emissions in 2025 from the 2014 ozone RIA (6.29 million tons), we constructed an assessment following these basic steps for the 34 affected states.

1. Capture reductions from the updated base case in the final CPP RIA (0.06 million tons);
2. Capture reductions due to the final Clean Power Plan (0.18 million tons);

⁶⁶ US EPA. 2014 Air Markets Program Data. All units in USA.

⁶⁷ EPA. March 2011. Revised BART Cost Effectiveness Analysis for Tail-End Selective Catalytic Reduction at the Basin Electric Power Cooperative Leland Olds Station Unit 2 Final Report.

⁶⁸ Assumes 10.5 MMBtu/MWh heat rate, 7% discount rate, 20 year book life.

⁶⁹ See Assumptions to AEO 2015, Electricity Market Module. Table 8.6. Coal plant retrofit costs.



3. Capture reductions from Texas and California to meet the current 75 ppb standard (0.24 million tons);
4. Capture reductions from all EPA known controls *except* at electric generating units (0.92 million tons);
5. Assume all coal-fired EGUs (not CHP) that emit above 0.17 lbs NO_x/MMBtu would require advanced controls or retire;
6. Assume units below 250 MW or 50% capacity factor would retire economically, at the same cost as the retrofit, to be replaced with a controlled NGCC;
7. Assume remaining unknown controls are met using cost curve half as steep as NERA's marginal cost of abatement, adjusted to meet the highest cost of known controls at the low end.

Overall, we found that using NERA's conservative cost-curve approach with the above corrections, an annualized cost for known and unknown controls for the year 2025 would be \$21.5 billion, above EPA's estimate of \$15 billion,⁷⁰ but a scant 14% of NERA's extraordinary \$155 billion annualized cost (see Figure 3). Moreover, assuming that only 660,000 tons of reductions are needed from unknown controls (as opposed to 750,000 tons as assumed by EPA) then EPA's cost estimate (using its methodology for costing unknown controls) would be \$13.6 billion, \$1.4 billion below the RIA's \$15 billion estimate.

We reviewed the RIA for the same 2025 Base Case assessed by EPA. Following the values shown in the third column of Table 5, we assessed the baseline emissions at 5.81 million tons after the final CPP, and the final target compliance emissions at 3.87 million tons. We followed EPA's price curve assumptions for all known controls except EGU, resulting in 0.92 tons to emissions reductions.

To evaluate more stringent end-of-pipe controls at EGUs and cost-effective coal plant closures, we evaluated EGU generation, capacity, and emissions from EPA's final Clean Power Plan RIA from August 2015 (mass-based compliance option). For each EGU identified, we characterized if it was in a modeling zone corresponding to an affected state, its NO_x emissions in 2025, capacity and capacity factor. Coal-fired units that emitted above 0.17 lbs/MMBtu NO_x were assumed to either retrofit with BACT-level SCRs or retire for replacement with SCR-controlled natural gas.

We assumed that smaller and low operations units would retire cost-effectively, at (or theoretically below) the all-in cost of an SCR. Units below 250 MW or producing at less than a 50% capacity factor were identified for retirement. We assumed the same cost for units undergoing retrofits and retirements, assuming that units which retire economically would do so at a price point below the cost of the retrofit. SCRs were priced according to EIA assumptions at five capacity increments.⁷¹ We applied

⁷⁰ See RIA, Table ES-8.

⁷¹ Assumptions to 2014 AEO. Electricity Market Module, Table 8.6. Prices range from \$183/kW for units \geq 700 MW to \$417/kW for units $<$ 100 MW.



an incremental fixed O&M charge of \$20/kW to all retrofits and retirements.⁷² We assumed that SCRs would result in BACT emissions of 0.07 lbs/MMBtu,⁷³ while retiring units would be replaced by NGCCs with SCRs at a 0.02 lbs/MMBtu emissions rate.⁷⁴ We leveled capital costs over a 20 year period at a 7% discount rate, and compared 2025 base case emissions against the controlled versions to derive total emissions reductions, and a cost per ton removed. Retirements or retrofits that resulted in units with NOx control costs above \$15,000 were excluded from the retrofit calculation (i.e. allowed to emit at their 2014 levels).⁷⁵

Table 5. Million tons of NOx Emissions, RIA, NERA, and Synapse Re-assessment

	EPA RIA (2025)	NERA (2022)	Synapse (2025)
Base Case Emissions	6.29	6.60	6.29
Updated 2015 Base Case			(0.06)
Reductions to CPP proposal	(0.31)		
Reductions to CPP final			(0.18)
Reductions to 75 ppb	(0.24)	(0.30)	(0.24)
Baseline Emissions	5.75	6.30	5.81
Known controls, minus EGU SCR	(0.92)	(0.80)	(0.92)
EGU SCR	(0.20)		(0.24)
EGU closures		(0.80)	(0.12)
Unknown controls	(0.75)	(1.00)	(0.66)
Compliance Emissions	3.87	3.70	3.87
<i>Total Reductions from Baseline</i>	<i>1.88</i>	<i>2.60</i>	<i>1.94</i>

4.2. Results

The analysis resulted in 360,000 tons of NOx reductions from existing coal-fired EGU through retrofit and replacement. Approximately 37 GW of coal units were maintained and retrofit while 16 GW of smaller units were retired. In total, we estimate an annualized cost of about \$2.1 billion, or an overall cost effectiveness of just under \$6,000 / ton NOx.

⁷² EPA. March 2011. Revised BART Cost Effectiveness Analysis for Tail-End Selective Catalytic Reduction at the Basin Electric Power Cooperative Leland Olds Station Unit 2 Final Report.

⁷³ Defined from the top quartile of SCR controlled coal-fired units in the AMPD dataset.

⁷⁴ NGCCs with 7.5 MMBtu/MWh heat rates.

⁷⁵ In almost all cases, units with extremely high control costs produce extremely little energy (and NOx). While we would normally assume that these units would likely retire on their own volition shortly at these levels of generation, we conservatively allowed these units to continue emitting with no controls. Ultimately, we excluded four units with capacity factors below 30%, amounting to 1.7 GW and producing 3,000 tons of NOx.



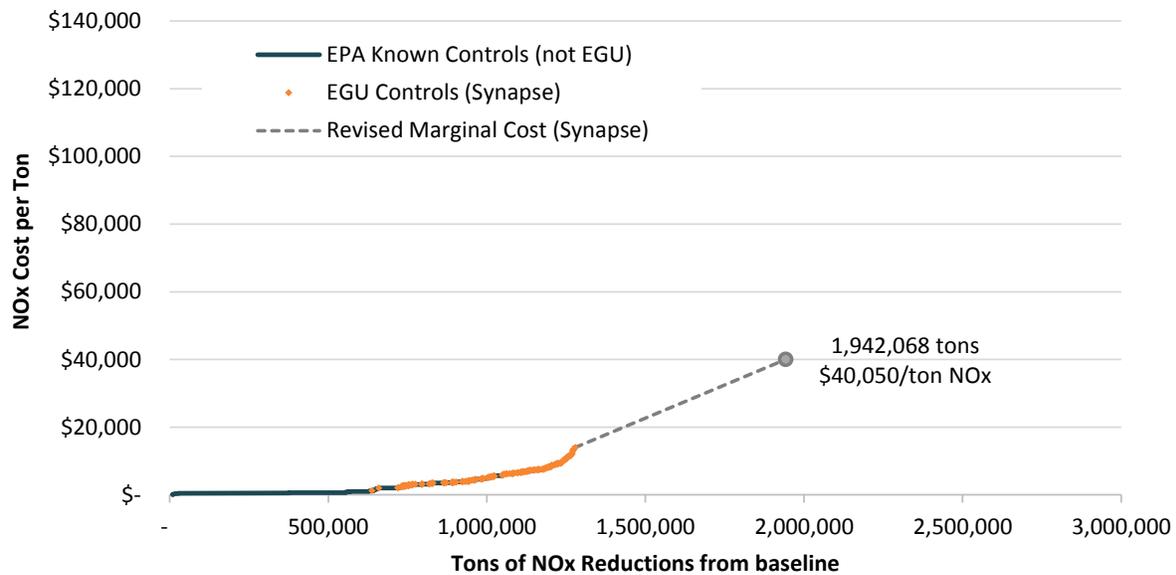
	NOx (tons)
EGU NOx after CPP (2025)	959,000
Reductions from retrofits	241,000
Reductions from retirements	119,000
Total EGU reductions	360,000
EGU NOx after Retirements & Retrofits	599,000

EPA’s RIA assumed 205,000 tons of emissions reductions from EGU (mostly through the installation of SCR). EPA’s analysis appears to have (a) assumed a low level of incremental control for most units (about 30-40% reduction) (b) availability of only 80% the eligible EGU identified here, and (c) no incremental unit retirements. Thus, we find an increment of about 155,000 tons of emissions reductions beyond what had been identified by EPA.

EPA estimated a requirement for 750,000 tons of “unknown” reductions above the known controls. By virtue of this wider set of controls, but adjusting for a less rigorous final Clean Power Plan, we estimate about 660,000 tons of emissions reductions remaining in the “unknown” bin.

We disagree with NERA’s assessment of long-range marginal costs for vehicle emissions reductions. Based on the cost of offsets in extreme NOx stressed regions (i.e. South Coast Air District), alternative academic studies indicating a lower cost for the “cash for clunkers” program, and the assumption that even vehicle scrappage programs could be targeted more effectively, we believe NERA’s marginal cost to be unreasonable. For the purposes of this re-assessment, we maintain a marginal cost curve similar in nature to NERA’s, but reduce the marginal cost of abatement by 50%, a reduction that is conservative compared to the broader range of costs implied by the Li, Linn, & Spiller paper. We maintain NERA’s assumption that the curve is linear, starting from the “anchor point” of the highest cost known control. In this case, the highest cost known control is a \$14,000 / ton SCR (see Figure 6, below). Following the curve from the anchor to the marginal abatement cost, we arrive at a \$40,000/ton maximum cost for unknown controls.

Figure 6. Supply curve for NOx emissions reductions. EPA known controls, Synapse EGU controls, modified marginal abatement cost.



Overall, known controls identified by EPA and additional SCR control and retirement costs identified by Synapse amount to \$3.7 billion (annualized).⁷⁶ The additional cost of unknown controls (using NERA’s cost-curve approach) would be \$17.9 billion (annualized). In total, we estimate that under NERA’s cost-curve approach, the cost of the 65 ppb ozone standard should be \$21.6 billion (annualized) – far below NERA’s erroneous \$155 billion estimate.

If we substitute our estimate of reductions needed from unknown controls for EPA’s estimate, then the cost of the 65 ppb ozone standard using EPA’s unknown cost methodology becomes \$13.6 billion, as opposed to the \$15 billion estimated in the RIA.

⁷⁶ EPA known control costs, with the exception of EGU controls, from Ozone RIA docket supporting information, “Copy of 2014 O3 NAAQS RIA Control Strategy Results NOx Controls for 65 ppb Analysis Incremental to Baseline” filed in docket as EPA-HQ-OAR-2013-0169-0015. EGU retrofit and replacement costs derived as in section 4.1 (page 28).

5. ECONOMIC IMPACT OF MEETING THE 65 PPB OZONE STANDARD

5.1. NERA's economic impact estimates would decrease with more realistic cost assumptions

The sponsor of the study, National Association of Manufacturers (NAM), has stated that the ozone standard is “the most expensive regulation ever issued by the government”.⁷⁷ NERA's supporting analysis concludes that the 65 ppb ozone rule will result in average annual loss of \$140 billion per year of Gross Domestic Product (GDP) and loss of 1.4 million job-equivalents.⁷⁸ To put this in perspective, NERA is predicting about a one percent decrease in GDP and the equivalent of one percent decrease employment due to the ozone standards. Both NERA and NAM have predicted sharp economic consequences to other regulations in the past.⁷⁹ (NERA's approach to employment impacts is flawed for reasons we explain below.)

As discussed above, NERA has grossly overestimated the cost of achieving the emission reductions needed to meet a revised ozone standard. Synapse estimates that – even assuming the basic validity of NERA's cost curve approach – NERA has overestimated compliance costs by more than a factor of seven (1/7th). Not having access to NERA's NewERA model, we cannot estimate how the overestimate affects NERA's projection of GDP impacts. Making the simplified assumption that the impacts would scale perfectly with compliance costs would lead to an 85% drop in NERA's estimates of GDP and thus an 85% drop in its job-equivalent estimates. In reality, there is good authority for finding that stronger ozone standards will strengthen the economy.

⁷⁷ National Association of Manufacturers (NAM). *New NAM Analysis Confirms: Federal Ozone Regulation Could Be Costliest in U.S. History*. Available at: <http://www.nam.org/Issues/Energy-and-Environment/Ozone/Economic-Impact-of-Proposed-EPA-Regulation-2015.pdf>

⁷⁸ NERA 2015, p.1

⁷⁹ An analysis done by NERA for NAM estimated that a carbon tax of \$20 per ton would lead to 3.8 million job-equivalent losses and 0.6% decrease in U.S. GDP by 2053. This study also estimated that a more stringent carbon regulation--an 80% reduction in carbon emissions by 2053--would result in a decrease of 10% of all job-equivalents (20 million) and 3.6% decrease in U.S. GDP. (NERA. *Economic Outcomes of a U.S. Carbon Tax*. February 26, 2013. Figures 2 and 3. Available at: <http://www.nam.org/Issues/Tax-and-Budget/Carbon-Tax/2013-Economic-Outcomes-of-a-US-Carbon-Tax-Full-Report.pdf>) NAM commissioned a 2014 study that claimed the total annual costs of federal regulations were \$2 trillion. The study appears to count employer contributions to Social Security, plus pay for vacations, holidays, and sick time, as costs of regulation. (NAM. *The Cost of Federal Regulation to the U.S. Economy, Manufacturing and Small Business*. September 2014. Available at: <http://www.nam.org/Data-and-Reports/Reports/Cost-of-Federal-Regulations/The-Cost-of-Federal-Regulation/>)

5.2. Environmental regulations have been found to have a positive or neutral impact on the economy

Compliance with environmental regulations can increase economic activity. Coal retirements and retrofits would create new construction and operations activity. A Ceres and Political Economy Research Institute (PERI) estimated that nearly 300,000 jobs per year would be created through installation of pollution controls and building new capacity to comply with two rules under the EPA's Clean Air Act.⁸⁰

Most of the costs to comply with the ozone standard are designated as “unknown” in the NERA study. There is much discussion of how both “known” and “unknown” compliance costs are treated in the NewERA model. The key compliance costs include: retrofits of coal plants, retirement of coal plants and trading in older cars for cars with lower emissions. However, there is very little discussion about how the new economic activity spurred by these actions is captured in the results, if at all. NERA mentions that the study includes “the positive benefits of increased labor demand in sectors providing pollution control equipment and technologies.” The positive impacts of this activity, however, are not presented. Reviewing NERA's model results, it appears that NERA likely excludes any of the economic benefits of their unknown control cost measures –i.e. the organization's model assumes that money spent on new cars simply disappears into the ether. Further, nowhere does NERA account for the health and related benefits of a stronger ozone standard, valued by EPA at as high as \$38 billion/year outside of California, and \$4.1 billion/year in California. RIA ES-14 to -17.

The impact of a regulation depends on how the compliance costs are reallocated to the rest of the economy and the equipment and installation required. For example, in another study also using the NewERA model, NERA concluded that carbon regulation would hurt the economy.⁸¹ By contrast, other analyses that do not use the NewERA model have found that reducing carbon emissions could be positive for the economy. Analysis Group found that the U.S. northeast's carbon cap and trade system--Regional Greenhouse Gas Initiative (RGGI)—reduced customer bills and created jobs. The report concluded that “in the end, consumers gain because their overall electricity bills go down as a result of state RGGI allowance revenue investments, primarily in energy efficiency but also renewable energy-focused programs.”⁸² A recent Synapse study found that a scenario with 84% carbon reductions by 2040 resulted in lower electricity system costs and customer bills.⁸³ This study also lists several other institutions that found economic benefits to carbon reductions.⁸⁴

⁸⁰ Ceres and PERI. *New Jobs—Cleaner Air: Employment Effects Under Planned Changes to the EPA's Air Pollution Rules*. February 2011. Available at: <http://www.ceres.or/resources/reports/new-jobs-cleaner-air>

⁸¹ NERA 2013.

⁸² Analysis Group. *The Economic Impacts of the Regional Greenhouse Gas Initiative on Nine Northeast and Mid-Atlantic States*. p.7. Available at: http://www.analysisgroup.com/uploadedfiles/content/insights/publishing/analysis_group_rggi_report_july_2015.pdf

⁸³ Synapse Energy Economics. *Lower Electric Costs in a Low Emission Future*. July 2015.

⁸⁴ *Id.* Table 1.



Meanwhile, an in-depth review of academic research on the employment impacts of environmental regulations found that either job gains or losses are possible, and that most estimates suggest the overall effect is close to zero – because regulatory costs are usually too small to make a big difference in a firm’s profitability or level of operations.⁸⁵

5.3. NERA wrongly assumes that pollution controls reduce economic activity elsewhere

According to NERA, additional emission controls (e.g. SCR) can only be installed at the expense of other industry. NERA assumes that spending on emission controls is “unproductive” and would “crowd out” productive investment in the broader economy.⁸⁶ This “scarcity effect” leads to higher costs of capital in the whole economy.⁸⁷ In reality, pollution control investment decisions have a *de minimis* or likely no effect on the costs of capital elsewhere.

Crowding out could be a problem in a full-employment economy, if all resources were already in use. Under that assumption, investment in emission controls would have to come at the expense of other investments, bidding up the cost of capital. This assumption does not comport with the functions of the economy today. When there is slack in the economy and investment is limited by the lack of profitable opportunities rather than the lack of funds (as is frequently, and currently, the case), then emission control requirements can impel companies to borrow more or spend their idle cash, increasing total investment and stimulating the economy.

Thus it is incorrect to assume that there is a scarcity of capital in the economy such that new investments in pollution control increase other industries’ costs of doing business. This flawed assumption is critical to the NERA prediction that ozone regulation will negatively impact the economy.

5.4. NERA assumes lower wages and lower desire to work

According to NERA, industries’ increased costs lead to decreased wages, causing lower employment. NERA explains the logic as follows:

Wage rates decline because companies have higher costs and lower labor productivity due to compliance costs. Lower real wage rates reduce workers’ incomes even if they continue to work the same number of hours. However, a lower real wage rate also decreases people’s desire to work. With fewer hours worked, total labor income

⁸⁵ Cary Coglianese, Adam M. Finkel, and Christopher Carrigan, editors, *Does Regulation Kill Jobs?*, University of Pennsylvania Press. 2014.

⁸⁶ NERA 2014, p. A-10.

⁸⁷ *Id.*

declines by a greater percentage than does the wage rate (an average of 1.9% over the period).⁸⁸

This statement, which is a key to the logic of NERA's results, rests on three spurious beliefs:

- 1) that investments in ozone-reducing equipment are expensive, dramatically lowering labor productivity;
- 2) that wages are tightly tied to labor productivity, and would fall by a noticeable amount due to the ozone rule; and
- 3) that workers would work less once those wages go down.

Reality is different in each of these areas:

- 1) The costs of compliance with the ozone rule are much smaller than NERA assumes, as noted above; hence the effects on productivity and profits are also smaller
- 2) Wages have not kept up with increases in productivity in recent years, a widely discussed economic trend. If wages have not followed productivity upward, there is no reason to expect them to follow a small downturn in productivity.
- 3) Even if a small change in middle-income (or higher) wage levels occurred, it is unlikely to affect the number of people willing to work at jobs impacted by the regulations, or the number of hours they work.

5.5. NERA's model assumes full employment yet is used to predict losses of job-equivalents

The NewERA model is not built to predict actual job creation or losses. The model assumes that the economy is in "full employment," meaning that everyone looking for work can find it.⁸⁹ In recent memory, the U.S. has reached this status only for a few years in the late 1990's and early 2000's.⁹⁰ NERA states that their "results relate to the longer-term effects on labor income and voluntary reductions in hours worked rather than involuntary unemployment impacts." In NERA's model, the job market is always booming—no jobs are ever lost, by definition. (And if, in a full-employment world, people voluntarily choose not to work at paid employment, that choice must make them better off in terms of personal welfare; otherwise, they would continue to work. There is no logical basis for viewing such choices as losses.)

NERA's claim that 1.4 million job-equivalents will be lost does not literally mean a loss of jobs. Since NERA assumes full employment as a starting point and there is great interest in estimating employment

⁸⁸ NERA 2014, p.27.

⁸⁹ NERA 2014, p.A-12.

⁹⁰ Since 1980, the annual average unemployment rate has been below 5% only in 1997-2001 and 2006-2007.



impact, NERA has calculated a “job-equivalent” measure: the NewERA model’s prediction of reduced labor income divided by the average labor income per job. Job-equivalents are the number of jobs that would be lost, in a world in which job losses were possible (i.e., not the NewERA model), if everyone was paid the average wage. According to NERA:

This measure **does not represent a projection of numbers of workers that may need to change jobs and/or be unemployed**, as some or all of the loss could be spread across workers who remain employed, thereby impacting many more than 1.4 million workers, but with lesser impacts per worker.⁹¹ (emphasis added).

Thus, NERA does not even purport to predict that anyone will become unemployed as a result of a revised ozone standard.

5.6. NERA’s job-equivalents are being misrepresented as “jobs”

Although the report discusses the fact that a decrease in job-equivalents does not mean that jobs will be lost, others reporting on the study have missed this nuance, including NAM – the industry group that funded it. Headlines discussing the study include:

- An article entitled “STUDY: Trillions in Costs, Millions of Jobs Lost from New EPA Ozone Regulation” claims that the report shows a “result in 1.4 million fewer jobs.”⁹²
- An article entitled “The real ozone threat to is to jobs” (posted on NAM’s website) claims that the standard “could lead to 1.4 million fewer U.S. jobs.”⁹³
- A message from NAM’s CEO entitled “Don’t Let New Regulations Tank Our Economy” claims that the more stringent 60 ppb ozone standard “will cost millions of jobs” and “stop the manufacturing comeback in its tracks”.⁹⁴
- The NAM CEO also authored an op-ed in the Wall Street Journal entitled “The EPA’s Latest Threat to Economic Growth” claiming that the 60 ppb ozone standard will “put millions of jobs at risk.”⁹⁵

⁹¹ NERA 2015, p.1.

⁹² McCoy, Shawn. Inside Sources. “STUDY: Trillions in Costs, Millions of Jobs Lost from New EPA Ozone Regulation”. February 26, 2015. Available at: <http://www.insidesources.com/study-trillions-costs-millions-jobs-lost-new-epa-ozone-regulation/>

⁹³ The Robesonian. “The real ozone threat to is to jobs”. June 13, 2015. Available at:

[http://www.nam.org/Newsroom/In-The-News/2015/The-real-ozone-threat-is-to-jobs-\(The-Robesonian\)/](http://www.nam.org/Newsroom/In-The-News/2015/The-real-ozone-threat-is-to-jobs-(The-Robesonian)/)

⁹⁴ NAM. *New EPA Ozone Regulations Could Be Costliest in U.S. History*. July 31, 2014. Available at:

<http://www.nam.org/Newsroom/Press-Releases/2014/07/NAM--New-EPA-Ozone-Regulations-Could-Be-Costliest-in-U-S--History/>

⁹⁵ Timmons, Jay. Wall Street Journal. “The EPA’s Latest Threat to Economic Growth”. August 13, 2014.



NERA concedes that it does not estimate job losses--in fact, its model makes it impossible to do so--yet the model results are being misrepresented as such. Also, none of the above-referenced commentary mentions increased economic activity that will result from a stronger ozone standard.

5.7. NERA’s underlying assumptions and its NewERA model are a “black box”

Throughout, we have reported on information made available in the NERA study, which is far from sufficient to evaluate their work. NERA has not provided its detailed assumptions or access to its NewERA model. What is going on behind the scenes in this model is unknown. As with their estimate of the costs of compliance, we are left with limited information with which to assess their economic impact analysis. A study being advertised as demonstrating “the potential for significant and long-term damage to our economy” should be fully open to scrutiny, but NERA’s key assumptions, modeling methods, and data are cloaked in secrecy.

6. CONCLUSIONS

To recap the major points discussed in this report:

1. NERA chose a significantly higher quantity of emission reductions needed from unknown controls than the EPA estimated were needed, but did not document why it did so. It appears to have drawn some values from the RIA for reference, but re-created other values from its black-box, proprietary model. Analysis by Synapse shows that NERA significantly overestimated the level of NO_x reductions required to meet a 65 ppb ozone standard, by erroneously bumping up the need for unknown controls. NERA also irrationally disqualified EPA’s Clean Power Plan as a mechanism for achieving NO_x reductions, unnecessarily increasing the amount of reductions needed from unknown controls.
2. NERA further grossly inflated the cost of meeting a revised standard by basing the expense of achieving unknown reductions on extreme cost estimates for the CARS “cash for clunkers” program. CARS was tuned to spur investments, not reduce NO_x.
3. NERA’s total cost of compliance is grounded in bad math. NERA double-counts the costs of reductions at coal-fired power plants, characterizing them both as known costs and unknown costs, thereby inflating the cost of compliance by nearly 200%.
4. Even using NERA’s own basic methodology, correction of the above-referenced flaws in NERA’s analysis leads to costs for known and unknown controls for the year 2025 of \$21.5 billion – about 1/7th of NERA’s estimate. Further, applying our analysis of NO_x reductions available from existing coal-fired EGU retrofits and replacements to EPA’s methodology for calculating cost produces annualized costs for known and unknown controls for 2025 of \$13.6 billion, or \$1.4 billion *lower* than the estimate in EPA’s assessment



5. NERA's economic and job impact estimates are grossly inflated due to the flawed compliance cost estimates cited above and deeply flawed assumptions that are not based on economic reality and that ignore economic stimulus that results from investment in pollution controls. NERA's assumptions that pollution controls will reduce economic activity elsewhere and that high compliance costs will force wages down and thus reduce productivity do not reflect actual economic trends.
6. Further, NERA's analysis should be rejected from serious discussion of the costs of the proposed rule because it is not auditable. Any analysis considered in governmental decision-making should be transparent and report verifiable data. Instead, NERA uses a "black box" proprietary model, fails to document its assumptions, and provides inconsistent and unreliable data. NERA's analysis is neither replicable nor reliable.



APPENDIX: NERA'S 2022 COMPLIANCE DEADLINE

Under the Clean Air Act, areas that violate air quality standards for ozone are classified according to the extent to which they exceed the standard. There are five classifications denoting an area's ozone nonattainment status: marginal, moderate, serious, severe, and extreme. Areas with more stringent classifications are given more time to attain the standard, but are subject to stronger, more prescriptive anti-pollution requirements. For example, a "marginal" area has three years from the time it is designated to meet the standard and is subject to relatively few specific anti-pollution requirements. On the other hand, an extreme area is subject to numerous prescriptive anti-pollution requirements and has 20 years to meet the standard. Areas that fail to meet the standard by the deadline for their classification are reclassified ("bumped up") to the next highest classification.

In its report, NERA assumed that all nonattainment areas, other than Utah and California, would have to meet the new ozone standard by 2022 at significant cost. If the final standard is promulgated in October 2015, as expected, and EPA makes designations within two years (October 2017), as is generally required by the Clean Air Act, then NERA is assuming that all nonattainment areas will have five years to comply (October 2022). NERA does not explain the source of this date. A 2022 deadline comes closest to the "moderate" area attainment date of six years from the date the area is designated nonattainment. Assuming designations occur by October 2017, the moderate area attainment date would be October 2023.

NERA's 2022 date also fails to account for the availability of up to two one-year extensions of the attainment date where an area is close to meeting the standard. Nor does it account for bump ups for areas that do not or cannot attain by the relevant deadline. For example, a moderate area that does not attain by the applicable deadline must be bumped up to serious, which will extend the attainment deadline by 3 years (i.e., to 2026). And a serious area that does not timely attain must be bumped to "severe", which extends the attainment deadline by another 7 years (2032). Moreover, an area can voluntarily choose to bump up to a higher classification at any time. Thus, if an area truly could not meet an attainment date without incurring extreme and unreasonable costs, it can secure more time.⁹⁶ For all these reasons, NERA's claim that communities will incur extreme costs to meet a 2022 attainment date is simply not credible.

⁹⁶ Some costs could be associated with the additional measures required for higher classifications. Neither the RIA nor NERA's analysis separately identify such costs, many or all of which would likely overlap with the cost of "known" controls. Moreover, many areas of the nation are already subject to the more stringent requirements for the higher classifications by virtue of having been put in those classifications for prior ozone standards. EPA's anti-backsliding rules limit the ability of such areas to relax controls required under their pre-existing classifications.