Prepared Statement of
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at a Hearing on
Impacts of U.S. Environmental Protection Agency Regulations
by the
Committee on Oversight and Government Reform
United States House of Representatives
Washington, DC

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Mr. Chairman and Members of the Committee:

Thank you for your invitation to participate in today's hearing. I am David Harrison, Jr. I am an economist and a Senior Vice President of NERA Economic Consulting. I am also Co-Head (along with Dr. Anne Smith) of NERA's global environmental practice.

I have evaluated major environmental policies for more than forty years as an academic, public official and consultant, beginning in 1974 when I was a member of a National Academy of Sciences research team engaged by the U.S. Congress to evaluate the costs and benefits of the federal automotive emission standards established in the 1970 Clean Air Act. During the administration of President Jimmy Carter, I was a Senior Staff Economist at the President's Council of Economic Advisors, where I had responsibility for energy and environmental policy. I was the senior staff on the Regulatory Analysis Review Group, a White House group established to review major federal regulatory proposals, and was a member of the Regulatory Council, an interagency group that formulated guidelines for preparing economic analyses of federal regulations.

After leaving the President's Council of Economic Advisors, I returned to Harvard University as an Associate Professor at the John F. Kennedy School of Government, where I taught courses in energy and environmental policy, benefit-cost analysis and other subjects. For the past 25 years I have been a consultant at NERA, where I have evaluated numerous energy and environmental policies on behalf of many private and public clients, including the European Commission, the UK government, the U.S. Environmental Protection Agency, and the South Coast Air Quality Management District. I have a Ph.D. in Economics from Harvard University, a M.Sc. in Economics from the London School of Economics and a B.A. in Economics from Harvard University.

I thank you for the opportunity to share my perspective today on the costs and other impacts of major proposed rulemakings of the U.S. Environmental Protection Agency (EPA). My written comments are based upon two recent NERA studies, one related to the national ambient air quality standard for ozone that was released in July 2014 (NERA 2014a) [1] and one related to the proposed Clean Power Plan (CPP) that was released in October 2014 (NERA 2014b).[2] Both studies were done in collaboration with Dr. Anne Smith, who is submitting testimony in this same hearing regarding the potential benefits of these proposed regulations. We are currently updating our ozone study to

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[1] NERA Economic Consulting. 2014a. *Assessing Economic Impacts of a Stricter National Ambient Air Quality Standard for Ozone*. Prepared for the National Association of Manufacturers, July 2014.

[2] NERA Economic Consulting. 2014b. *Potential Energy Impacts of the EPA Proposed Clean Power Plan.* Prepared for American Coalition for Clean Coal Electricity, American Fuel & Petrochemical Manufacturers, Association of American Railroads, American Farm Bureau Federation, Electric Reliability Coordinating Council, Consumer Energy Alliance, and National Mining Association. October 2014.

reflect updated information made available by EPA in November 2014 when it released its proposed revision of the ozone standard. My written and oral testimonies reflect my own opinions, and do not represent any position of my company, NERA Economic Consulting or of any of its clients.

I. Potential Costs and Economic Impacts of a Stricter Ozone Standard

Background on the Ozone Standard

The U.S. Environmental Protection Agency (EPA) has responsibility under Sections 108 and 109 of the Clean Air Act to establish, to review and to revise (as appropriate) a primary NAAQS that protects the nation's public health with an "adequate margin of safety." This assessment is made by the EPA Administrator based upon a review of various EPA assessments as well as review of advice from the Clean Air Scientific Advisory Committee (CASAC). Once a national standard is revised, states have the responsibility to develop State Implementation Plans (SIPs), documents that describe how the states will ensure that regions within their jurisdiction will attain and maintain the standard. States typically are given attainment deadlines that vary depending upon the severity of nonattainment. EPA has set NAAQS for six principal pollutants.

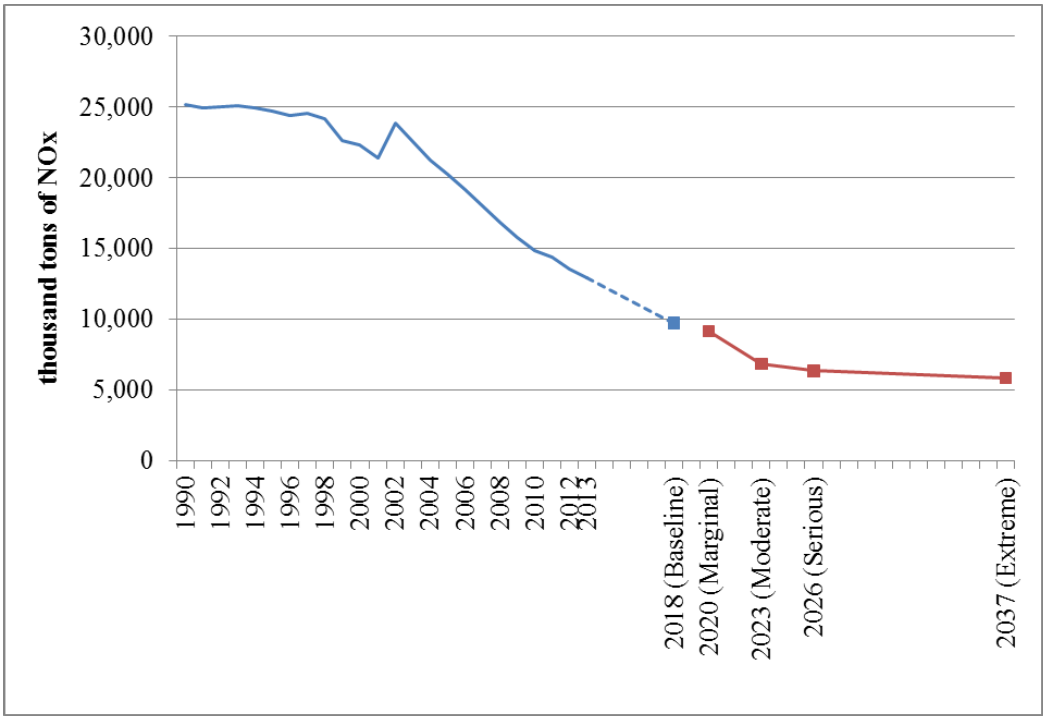
The Clean Air Act instructs EPA to review the NAAQS every five years. At the time of our study, the EPA was in the process of developing such a review and proposal, which was ultimately released in November 2014. In March 2008, the EPA had set an ozone standard of 75 parts per billion (ppb). In 2010, EPA reconsidered the ozone standard and evaluated lower potential standards, including 60 ppb. At the time of our study, EPA had stated its intention to consider tightening the standard to as low as 60 ppb. Our study thus evaluated a new ozone standard of 60 ppb, one value that seemed likely to be included in the new EPA proposal.

At the time of our study, EPA had not released any new ozone compliance cost estimates since its 2008-2010 analyses. The Agency had issued some updated information on projected baseline emissions, however. In addition, there was updated information on monitored ozone concentrations that indicated the air quality regions and states most likely to be designated in nonattainment with a 60 ppb standard. The updated information allowed us to develop estimates of the emissions reductions that would be required for these states to come into attainment, which we used to develop estimates of the costs of such a tightened NAAQS for ozone. The information EPA had made available was limited, however, and one purpose of our analysis was to illustrate the approach and types of data that we thought EPA should develop to provide a sound understanding of the economic impacts of a new ozone NAAQS. The approach and data development that are needed would be the same whether EPA chose to propose a standard of 60 ppb, as we analyzed in our July 2014 study, or some other level.

Background on Historical Trends in Ozone Precursor Emissions

One important point to note is that the ozone precursor emissions in the United States have declined dramatically in the last 25 years. Figure 1 shows that national anthropogenic NO_X emissions decreased from about 25.2 million tons in 1990 to 12.9 million tons in 2013, and that EPA projected that emissions would decrease to 9.7 million tons by 2018. The EPA information indicated that U.S. NO_X emissions would need to decrease to about 5.8 million tons to meet a 60 ppb standard throughout the country (as shown in the red line, which shows our assessment of the timing of the required reductions of about 3.9 million tons).

Figure 1: U.S. NO_X Emissions to Attain 60 ppb NAAQS Compared to Historical NO_X



Notes: Blue solid line: estimated historical emissions; blue dotted line: projected further declines through 2018; Red line: emissions to attain 60 ppb on attainment schedule.
The slight increase in U.S. NO_X emissions from 2001 to 2002 primarily reflects changes in EPA's emission modeling methodology for onroad and nonroad sources (switching from MOBILE6 to the National Mobile Inventory Model and MOVES)

Source: NERA (2014a) Figure S-1

Objectives of Our July 2014 Study

Our July 2014 study had two principal objectives:

1. Assess the costs and economic impacts of a 60 ppb ozone standard using the best available information from EPA and other sources; and

2. Develop recommendations for additional and updated information and analyses EPA should provide in its regulatory impact analysis (RIA) of a proposed rule, so that such assessments could be more fully evidence-based.

The first objective was predicated on the large potential significance to the U.S. economy of a more stringent ozone standard as indicated by EPA's own prior partial estimate (excluding costs in California) that the annualized costs would be $90 billion per year in 2006 dollars ($102 billion in 2013 dollars) to achieve a 60 ppb standard using one of EPA's calculation methodologies.[3] Unlike regulations that target specific sectors, an ozone standard would directly affect virtually every sector of the economy, because ozone precursors (oxides of nitrogen, or NO_X, and many types of volatile organic compounds, or VOCs) are emitted by a wide range of stationary, mobile, and area sources. Moreover, a tightened standard might result in other effects, notably potential constraints on domestic natural gas and crude oil development activity if nonattainment regions introduce permitting barriers or require emissions offsets to develop new wells and processing facilities.

The second objective of this study related to EPA's process of updating its analysis as it prepared its RIA. Our analysis revealed major gaps in information on compliance technologies and their costs and in other important information. Our research thus put us in a position to recommend information that EPA should develop and make

[3] U.S. Environmental Protection Agency (EPA). 2010b. *Supplemental Regulatory Impact Analysis (RIA) for the Reconsideration of the 2008 Ozone National Ambient Air Quality Standard (NAAQS)*. http://www.epa.gov/ttn/ecas/regdata/RIAs/s1-supplemental_analysis_full.pdf

available in order to provide comprehensive and reliable assessments of the economic impacts of a more stringent ozone standard.

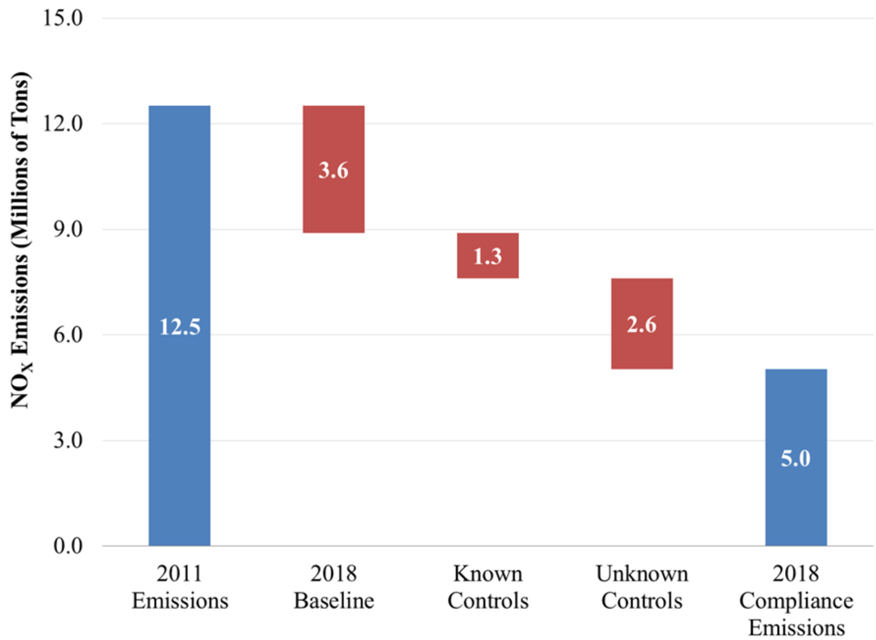
Methodology of the NERA July 2014 Study

Our 142-page July 2014 report provides details of the methodology we used to develop our estimates of compliance costs and to model the macroeconomic impacts of a 60 ppb ozone standard. Our compliance costs were based upon four major sources of information: (i) the most recent EPA information on projected 2018 baseline VOC and NO_X emissions supplemented by baseline emission projections for electric generating units (EGUs) from N_{ew}ERA, our integrated energy-economy model; (ii) our assessments (based upon earlier EPA analyses) of emission reductions that would be required for all regions of the United States to come into attainment; (iii) cost and emission reduction information that EPA had developed for what it referred to as "known" controls; and (iv) our estimates of the emission reductions and potential costs per ton of what EPA referred to as the "unknown" controls necessary to achieve attainment in each affected state.

The waterfall chart of Figure 2 summarizes estimates of the emission reductions needed in the 40 states EPA's information indicated would need to reduce NOx emissions in order to achieve a 60 ppb standard. The first reduction block consists of baseline reductions from 2011 to 2018 due to changes in activity and other non-ozone regulations presently being implemented. We treated these as costless (although we included the costs of controls to achieve the existing 75 ppb standard that have not been implemented). The second block is EPA's list of "known" controls, i.e., controls for which EPA had developed cost information. We used EPA's cost estimates for "known" controls. The third block is reductions that EPA called "unknown" controls, i.e., controls for which EPA had not developed specific cost information.

One critical point to note is the significance of "unknown" controls. These controls represent 2.6 million tons of NO_X, or fully two-thirds of the emission reductions that we predicted would be required to achieve a 60 ppb standard based on the available EPA information.

Figure 2: NO_X Emissions and Categories of NO_X Reductions to Attain 60 ppb NAAQS (for 40 Non-Attaining States Only)



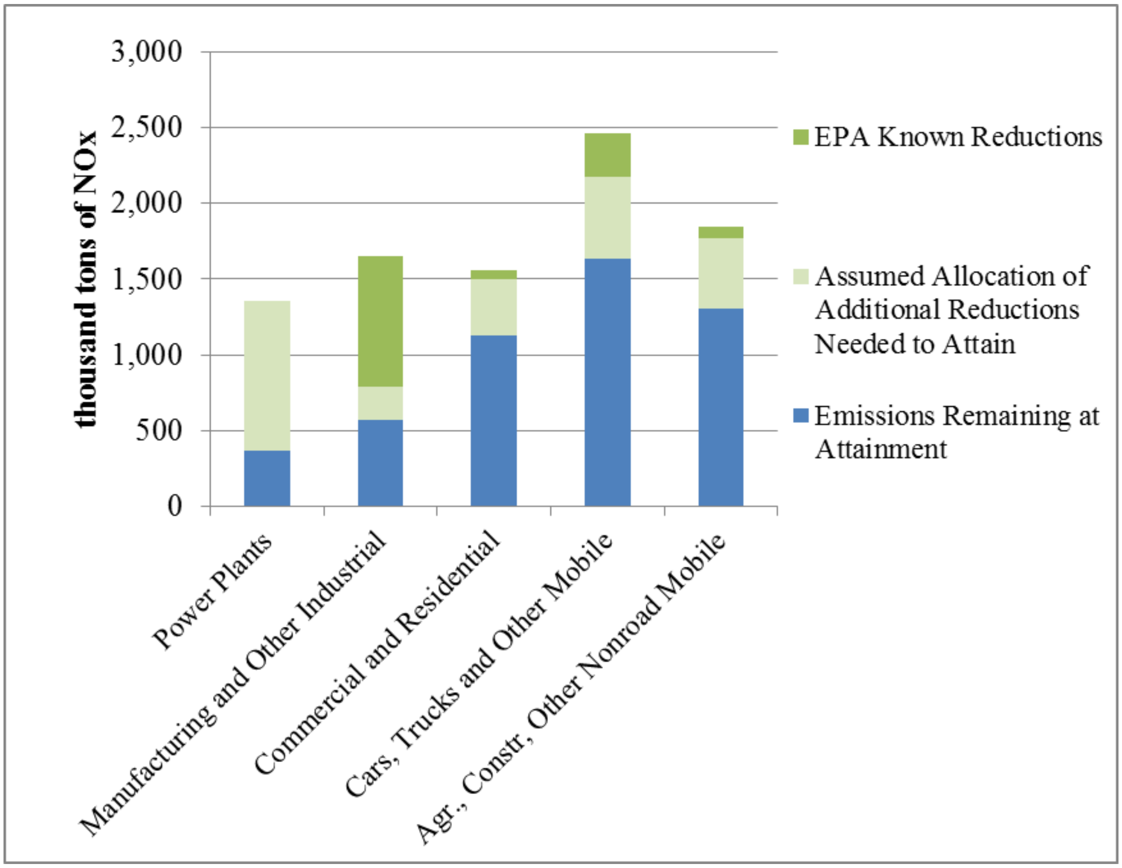
Note: Emissions and reductions include only states requiring emission reductions for compliance with a new ozone NAAQS of 60 ppb in the NERA (2014a) analysis.
Source: NERA (2014a) Figure S-2

EPA had developed a relatively simple methodology to estimate the costs of the "unknown" controls; this methodology did not use any information on the nature of the emissions that remained after "known" controls or the costs of any specific controls that could reduce these emissions.

In contrast to EPA's approach, we developed an evidence-based approach to estimating the potential costs of "unknown" controls. We evaluated the nature of the emission sources that remain (mostly from electricity generating units, or EGUs, and three types of non-point sources) and developed detailed estimates of the costs of reducing emissions from two significant categories (retirement of coal-fired power plants and scrapping of older cars and light-duty trucks).

Figure 3 shows the resulting mix of reductions assumed in our estimates of the compliance costs needed to achieve a 60 ppb ozone standard. The dark green shows EPA's "known" controls and the light green shows NERA's evidence-based assumptions regarding where "unknown" controls will likely come from. The remaining sum (shown in the blue bars) is 5.0 million tons—the aggregate limit to achieve attainment for the states projected to be in nonattainment under baseline 2018 emissions levels in our analysis. Our estimates assume deep cuts in the EGU sector, where emissions are concentrated in a few sources and costs per ton are thus lower than for the many smaller sources among the non-point source categories (i.e., area, onroad mobile and nonroad mobile). Our assumptions on "unknown" controls outside of the EGU sector involve much smaller incremental percentage reductions than from EGUs; but because these will require programs such as scrapping vehicles and other small sources, they are expected to come at a substantially higher cost per ton than the EGU controls—even though we assume that the scrapping programs only target the oldest, highest-emitting of each type of NO_X-emitting equipment.

Figure 3: NERA Analysis's Allocation of Additional Reductions Necessary to Attain a 60 ppb NAAQS to Categories of Emissions Sources in the 40 Non-Attaining States



Source: NERA (2014a) Figure S-4

N_{ew}ERA Model to Estimate Economic Impacts

We used NERA's N_{ew}ERA energy-economic model to develop estimates of the potential macroeconomic impacts on the U.S. economy of our estimates of compliance costs for attaining a 60 ppb ozone standard. The capital costs are incurred from 2017 until 2036 (the last projected compliance date, for extreme areas), while O&M costs are incurred for all years after compliance. Our economic impact analysis included the effects of costs incurred through 2040.

$N_{ew}ERA$ is an economy-wide integrated energy and economic model that includes a bottom-up, unit-specific representation of the electric sector, as well as a representation of all other sectors of the economy and households. It assesses, on an integrated basis, the effects of major policies on individual sectors as well as the overall economy. It has substantial detail for all of the energy sources used by the economy, with separate sectors for coal production, crude oil extraction, electricity generation, refined petroleum products, and natural gas production. The model performs its analysis with regional detail. This particular analysis uses state-specific cost inputs.

National Results of the July 2014 NERA Study

We estimated that the potential costs of achieving a 60 ppb ozone standard would have a present value of $2.2 trillion as of 2014 (based upon costs incurred from 2017 through 2040), as summarized in Table 1. As a rough point of comparison, EPA's annualized cost estimate from its 2010 analysis implied a present value of about $0.9 trillion.[4] The primary difference in our methodologies is the extrapolation method used to estimate the cost of "unknown" controls that were not identified in EPA's 2008-2010 analyses; we attempted to understand the kinds of controls that would be required after "known" controls and based our method on the estimated costs of one such control (vehicle scrappage), whereas EPA relied on an arbitrary extension from "known" control costs.

[4] Based on the annualized cost of $90 billion in 2020 for EPA's hybrid cost calculation with the middle slope parameter, converted to a present value over 20 years using a real annual discount rate of 5%, converted from 2006 dollars to 2013 dollars, and calculated as of 2014.

Table 1. Potential U.S. Compliance Spending Costs for 60 ppb Ozone Standard

	Present Value (Billions)			Cumulative
	Capital	O&M	Total	Coal Retirements
Compliance Costs	$1,190	$1,050	$2,240	101 GW

Note: Present value is from 2017 through 2040, discounted at a 5% real discount rate.
Cumulative coal retirements are incremental to baseline. These retirements are primarily due to assumed emission control measures but may also include indirect electric sector impacts of the ozone standards.

Source: NERA (2014a) Figure S-5

The potential costs we estimated for a 60 ppb ozone standard were projected to have substantial impacts on the U.S. economy and U.S. households. The national results were developed from detailed estimates of state-level impacts, which in the interest of brevity I am not reporting in this testimony. These state-level results indicated that although all states are affected—even those that do not incur compliance costs—the projected impacts of the 60 ppb ozone standard differ substantially by state. We also developed detailed estimates of the potential impacts on energy markets; again, in the interest of brevity, I am not reporting those results in this testimony. Moreover, I also do not present the results of a sensitivity case we evaluated based on the possibility that ozone standards would constrain future oil and gas production, particularly in rural areas. That sensitivity case resulted in much larger impacts on natural gas prices and increased the macroeconomic impacts by about 30 to 50%.

Table 2 shows the potential macroeconomic effects we estimated as measured by gross domestic product (GDP) and U.S. household consumption. The 60 ppb ozone standard was projected to reduce GDP from the baseline levels by about $3.4 trillion on a present value basis (as of 2014) and by $270 billion per year on a levelized average basis (spread evenly over years but retaining the same present value) over the period from 2017 through 2040. Average annual household consumption was projected to be reduced by about $1,570 per household per year.

Table 2. Potential Impacts of 60 ppb Ozone Standard on U.S. Gross Domestic Product and Household Consumption

	Annualized	Present Value
GDP Loss (Billions of 2013$)	$270/year	$3,390
Consumption Loss per Household (2013$)	$1,570/year	N/A

Note: Present value is from 2017 through 2040, discounted at a 5% real discount rate. Consumption per household is an annualized (or levelized) value calculated using a 5% real discount rate.
Source: NERA (2014a) Figure S-7

Table 3 focuses on several dimensions of projected impacts on income from labor ("worker income") as a result of the 60 ppb ozone standard. The projected impacts of the emissions reduction costs on labor income are substantial. Relative to baseline levels, real wages were projected to decline by about 1.2% on average over the period and labor income was projected to decline by about 1.9% on average, resulting in job-equivalent losses that average about 2.9 million job-equivalents. (Job-equivalents are defined as the change in labor income divided by the annual baseline income for the average job.) A loss of one job-equivalent does not necessarily mean one fewer employed person—it may be manifested as a combination of fewer people working and less income per worker. However, this measure allows us to express employment-related impacts in terms of an equivalent number of employees earning the average prevailing wage.[5]

[5] The N_{ew}ERA model, like many other similar economic models, does not develop projections of unemployment rates or layoffs associated with reductions in labor income. Modeling such largely transitional phenomena requires a different type of modeling methodology; our methodology considers only the long-run, equilibrium impact levels.

These are the *net* effects on labor and include the positive benefits of increased labor demand in sectors providing pollution control equipment and technologies.

Table 3. Potential Impacts of 60 ppb Ozone Standard on Labor

	Avg.
Baseline Annual Job-Equivalents (millions)	156
60 ppb Case:	
Real Wage Rate (% Change from Baseline)	-1.2%
Change in Labor Income (% Change from Baseline)	-1.9%
Job-Equivalents (Change from Baseline, millions)	-2.9

Note: Average (Avg.) is the simple average over 2017-2040. "Job-equivalents" is defined as total labor income change divided by the average annual income per job. 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

Source: NERA (2014a) Figure S-8

Need for More Complete Information

Our July 2014 study emphasized the need for EPA to develop more detailed information, particularly on control costs, in order to provide a more accurate assessment of the costs and potential impacts of a more stringent ozone standard. Our analyses uncovered numerous gaps that we recommended that EPA fill as it developed its Regulatory Impact Analysis (RIA) for its ozone proposal, with perhaps the most important gaps related to the identity of control options and their costs to achieve the emissions reductions needed for attainment. The bulk of estimated compliance costs to meet a 60 ppb standard in EPA's 2008-2010 analyses were based upon "unknown" controls, *i.e.*, controls that are not attributed to particular control technologies or even to particular sectors. We developed estimates of these "unknown" costs based upon an assessment of the available information. But we recommended that EPA update and expand its compliance cost information to provide a more comprehensive assessment of emission control options and compliance costs. Moreover, our sensitivity analysis including natural gas production constraints suggested the importance of this issue and thus the need for EPA to evaluate the potential impacts of a tighter ozone standard on domestic natural gas and crude oil production.

II. Potential Energy Impacts of the EPA Proposed Clean Power Plan

Background on the Clean Power Plan

EPA proposed the Clean Power Plan (CPP) in June 2014 as a nationwide regulation under Section 111(d) of the Clean Air Act.[6] The proposal would set maximum limits on CO_2 emission rates (measured in pounds of CO_2 per megawatt-hour (MWh) of generation and end-use energy efficiency according to a formula described below) for electricity systems within relevant states.[7] In EPA's preferred regulatory approach (labeled "Option 1"), the final CO_2 emission rate standards would apply in 2030, and in that year total U.S. power sector CO_2 emissions would be 30% below their level in 2005. EPA also developed and evaluated an alternative approach (labeled "Option 2") with final standards in 2025. EPA developed interim limits in addition to the final limits for each regulatory approach. The proposal would allow states to develop regional programs for collective CO_2 emission reduction, as in the Regional Greenhouse Gas Initiative (RGGI) in nine Northeastern states that began in 2009.

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[6] U.S. Environmental Protection Agency, "Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units; Proposed Rule." 79 Federal Register 34830-34958. June 18, 2014. http://www.gpo.gov/fdsys/pkg/FR-2014-06-18/pdf/2014-13726.pdf.

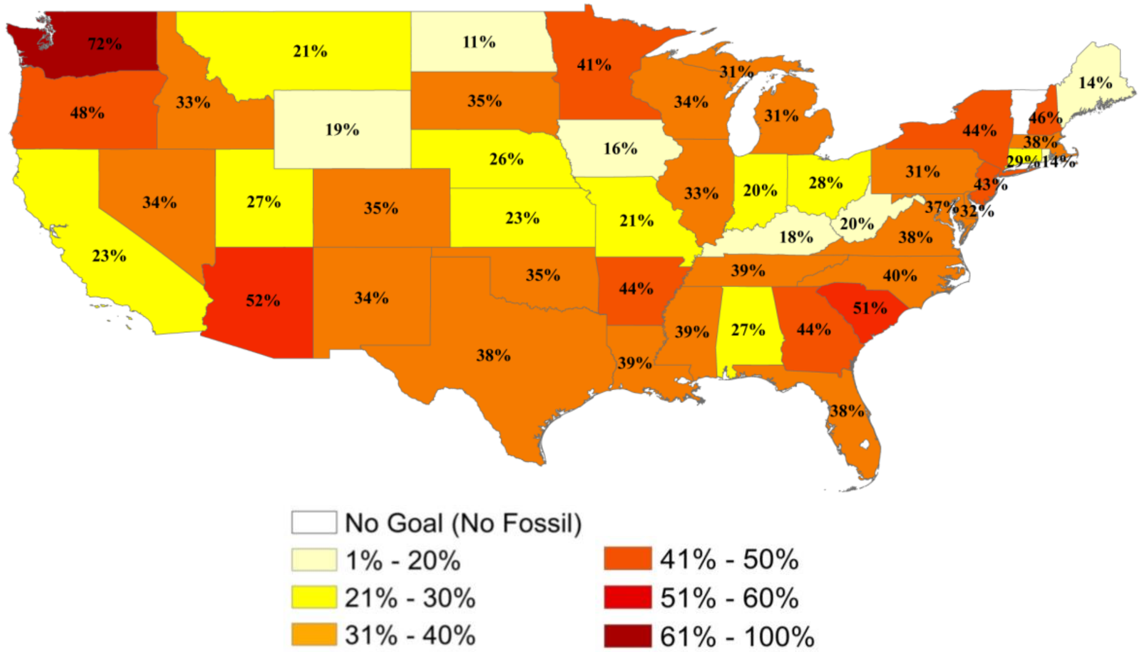
[7] The proposal does not set CO_2 emission rate limits for Vermont or Washington, D.C., because these jurisdictions do not have any affected fossil-fired power plants.

EPA set the state CO_2 emission rate limits based on their analysis of emission reduction opportunities in each state. EPA evaluated the opportunities in terms of four Building Blocks that can be summarized as follows:

1. Building Block 1—Heat rate improvements at coal units;
2. Building Block 2—Increased utilization of existing natural gas combined cycle (NGCC) units;
3. Building Block 3—Increases in renewables and nuclear energy; and
4. Building Block 4—Increases in end-use energy efficiency.

Figure 4 shows each state's reduction in CO_2 emission rate by 2030 as a percentage relative to each state's CO_2 emission rate in 2012, using EPA's emission rate formula and calculations.

Figure 4: CO_2 Emission Rate Reduction for 2030 Target Relative to 2012 Rate



Source: NERA (2014b) Figure 2

<u>Objectives of Our Study</u>

Our principal objective was to evaluate the potential energy market impacts and energy costs of the CPP, focusing on results over the period from 2017 through 2031 (2017 marking the beginning of the ramp up of EPA's assumed end-use energy efficiency and renewable generation, and 2031 representing the most stringent rates that are achieved by 2029). We developed impact estimates under two scenarios, both of which presume least-cost compliance by each state. (While appropriate for modeling, this least-cost presumption may lead to understating the real-world impacts and costs of the CPP.) The first scenario assumes that states are able to use all four Building Blocks and the second scenario assumes that states are constrained by legal considerations to only use Building Blocks 1 and 2 to show compliance with the targets in the CPP proposal.

1. *State Unconstrained (BB1-4)*. Each state complies with its targets, with all four Building Blocks available as compliance options.
2. *State Constrained (BB1-2)*. Each state complies with its targets; this scenario presumes that neither end-use energy efficiency (Building Block 4) nor renewables and additional nuclear energy (Building Block 3) would be available as compliance options.

We refer to the first scenario as a "state unconstrained" scenario to indicate that each state is presumed to comply using the least-cost mix across all four Building Blocks, although the specific mix of Building Blocks is limited to each state individually, and we assume there are no legal or implementation constraints to using all four Building Blocks. We refer to the second scenario as a "state constrained" scenario to illustrate the impact of state-by-state compliance with constraints, where states would only be able to use two of the four Building Blocks to demonstrate compliance. Despite the label "constrained," even in this scenario the states could still choose their preferred compliance mix, given the constraint. For our analysis, we assumed that each state chooses its own least-cost compliance strategy under both scenarios.

Methodology of the NERA Study

We evaluated the potential impacts of the two CPP scenarios using N_{ew}ERA, focusing on the electricity and related energy module. The N_{ew}ERA model was calibrated to the U.S. Energy Information Administration (EIA) Annual Energy Outlook (AEO) 2014 Reference Case projection. This reference case reflects current environmental regulations (e.g., Mercury and Air Toxics Standards) and other policies, as well as the

EIA's most recent projections of energy and economic activity. The Reference Case includes the effects of the two major existing programs to reduce CO_2 emissions, the Regional Greenhouse Gas Initiative (RGGI) and the California cap-and-trade program.

Building Block Assumptions

We developed assumptions about the costs and effectiveness of the different compliance options.

Building Block 1 – Heat Rate Improvements for Coal Units

In its calculations of state targets, EPA assumed that all coal units could achieve a 6% improvement in their efficiency (i.e., reduction in heat rate), and in its cost modeling EPA also assumed this 6% improvement could be achieved at a capital cost of $100/kilowatt (kW). We understand that various industry experts have concluded that these assumptions are unrealistic in light of practical engineering considerations, actual industry experience, and the incentives owners of electricity generators already have to improve plant efficiency. Our clients suggested an alternative set of assumptions, in particular, (a) for a cost of $100/kW, a maximum efficiency improvement of 1.5% would be achievable for the most inefficient existing units and a 0.75% improvement would be available for units with average efficiency, and (b) no efficiency improvements would be available to the most efficient units. We investigated the significance to our incremental energy cost estimates of these alternative sets of assumptions regarding potential heat rate improvements and found that this set of assumptions did not have a major effect on the results; using EPA's heat rate assumption rather than the alternative set resulted in less than a 1% change in our estimate of the overall energy system cost of the CPP in the unconstrained scenario. Thus, although we did not undertake an independent assessment to determine the most realistic set of assumptions, we adopted the alternative industry set of assumptions regarding potential heat rate improvements. We note that while this set of assumptions has *de minimis* impact on our estimates of the impacts of the proposed CPP, this issue would be much more significant if the Section 111(d) limits for legal reasons had to be based solely on systems of emissions controls that can be achieved on the existing fossil units themselves. In that legal situation, this uncertainty would warrant a more thorough treatment of heat rate improvement assumptions than we determined was necessary for our analysis.

Building Block 2 – Increased Utilization of Existing NGCC

In its calculation of state targets, EPA assumed that existing NGCC units could increase their utilization to a 70% annual capacity factor (subject to the availability of coal- and oil-fired units to be backed down) regardless of any engineering, regulatory, or infrastructure constraints.[8] Increasing utilization of existing NGCC units up to each unit's maximum availability[9] is an option in all of our scenarios. The estimated incremental cost of this action depends upon the relative costs of the alternative sources of generation, which vary by electricity market region; the specific units backed down to achieve any increase in generation from existing NGCC units are determined in N_{ew}ERA.

[8] Not all states are able to ramp up to 70%. Some states do not have sufficient coal- and oil-fired generation to be backed down; in this case, NGCC units were assumed to be able to ramp up to a level based upon backing out all coal- and oil-fired generation.

[9] For most units, the maximum availability is assumed to exceed 85%.

Building Block 3 – Increases in Renewable and Nuclear Generation

EPA's calculation of state targets includes the effects of added generation from existing and new non-hydroelectric units, existing nuclear generation termed "at risk," and new nuclear generation currently under construction. In all of our scenarios that include Building Block 3, additions of non-hydroelectric renewable and nuclear generation are presumed to be able to contribute to lowering emission rates, at the capital and operating costs that are standard in N_{ew}ERA.

Building Block 4 – Increases in End-Use Energy Efficiency

EPA's calculation of state targets was based upon its estimates of the quantities of end-use energy efficiency by state that could be added in each year based upon the programs adopted to-date in states with ambitious energy efficiency programs. EPA also provided estimates of the cost for this energy efficiency, with the first-year cost varying based on whether a state was adding less than 0.5% incremental energy efficiency ($550/MWh), between 0.5% and 1.0% ($660/MWh), or more than 1.0% ($770/MWh). EPA has translated the three first-year costs to levelized costs of 6.5¢/kWh, 7.8¢/kWh, and 9.1¢/kWh, respectively. We reviewed the literature and updated the cost estimates based upon a recent review by two prominent academic researchers;[10] the recommendation in this review implies a levelized cost of 10.6¢/kWh based on historical energy efficiency costs (including both utility costs and participant costs), which we presume relates to the EPA value for states adding less than 0.5% incremental energy

[10] Allcott, Hunt and Michael Greenstone. 2012. "Is There an Energy Efficiency Gap?" *Journal of Economic Perspectives*, 26(1): 3-28. http://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.26.1.3

efficiency. We scaled up EPA's first-year costs by the ratio of this value to the equivalent levelized cost for EPA (6.5¢/kWh), resulting in first-year energy efficiency costs of $896/MWh. We are not aware of any assessment regarding the extent to which energy efficiency costs may increase as the targets become more ambitious that is similar to the Allcott and Greenstone assessment on historical energy efficiency costs. Thus, we used the same assumptions as EPA regarding the changes, resulting in estimates of $1,075/MWh and $1,253/MWh (2011$) for the second and third levels of energy efficiency.

We modeled the adoption of energy efficiency as a compliance option based upon its cost relative to alternative means of reducing CO_2 compliance emission rates to comply with the CPP (using the same approach as EPA). As discussed in our report, however, there is a strong conceptual argument that cost-effective energy efficiency would be adopted in the absence of the CPP, i.e., in the baseline case to which the CPP case is compared in deriving the cost and impacts of the CPP.

National Energy Market Impacts of the Clean Power Plan

We estimated that the national energy market impacts of the CPP would be very substantial. The following tables provide our estimates of the energy sector impacts and energy costs of the two state compliance scenarios. The first scenario presumes that compliance costs are minimized using all four of the Building Blocks identified by EPA for the CPP targets. The second presumes that the same interim and final CPP state targets would have to be met, but that states would be constrained to using only Building

Blocks 1 and 2. In the interest of brevity, I focus on the results for State Unconstrained scenario in the following discussion.

Table 4 shows that the average annual energy system impacts of the Clean Power Plan would be very substantial. In the State Unconstrained (BB1-4) scenario, the annual average electricity sector CO_2 emissions would be reduced by about 22% relative to the reference case (not relative to 2005 emission levels) over the period from 2017 through 2031. Coal unit retirements would increase by about 45 gigawatts (GW). Coal-fired generation would decline by about 29% on average over the period, with natural gas-fired generation increasing by about 5% on average. The Henry Hub natural gas price would increase by about 2% on average. Delivered electricity prices would increase by about 12% on average over 2017 through 2031. However, these figures omit several factors that could add to impacts and costs.[11]

[11] Potential infrastructure costs related to natural gas pipelines, electricity transmission, and voltage support or ancillary services are not included. Low projected capacity utilization of non-retired coal units would lead to decreases in efficiency (*i.e.*, increases in heat rates), additional wear and tear costs from operating coal units in a cycling mode, and potentially additional retirements, none of which are included in our modeling. Costs related to unit ramp rate constraints, minimum load constraints, and delays in new build or retirement permitting are also not accounted for in our cost estimates.

Table 4. Overview of Energy System Impacts of State Unconstrained (BB1-4) and State Constrained (BB1-2) Scenarios (Annual Average, 2017-2031)

	Total Coal Retirements Through 2031	Coal-Fired Generation	Natural Gas-Fired Generation	Henry Hub Natural Gas Price	Delivered Electricity Price	Electricity Sector CO2 Emissions
	GW	TWh	TWh	2013$/MMBtu	2013 ¢/kWh	MM metric tons
Baseline	51	1,672	1,212	$5.25	10.8	2,080
State Unconstrained (BB1-4)	97	1,191	1,269	$5.36	12.0	1,624
Change from Baseline	+45	-481	+57	+$0.11	+1.3	-456
% Change from Baseline	+18%	-29%	+5%	+2%	+12%	-22%
State Constrained (BB1-2)	220	492	2,015	$6.78	12.6	1,255
Change from Baseline	+169	-1,180	+802	+$1.53	+1.9	-825
% Change from Baseline	+69%	-71%	+66%	+29%	+17%	-40%

Note: Coal retirements are cumulative from 2014. Percentage change in coal retirements is relative to total baseline 2031 coal capacity.

Source: NERA (2014b) Figure ES-1

Table 5 shows the energy system costs of the two scenarios, expressed as present values in 2014 of spending incurred over the period from 2017 through 2031. The costs are broken down into three categories: (1) costs to serve electricity load; (2) costs of the end-use energy efficiency programs, both to the utilities and to the participants; and (3) costs of non-electricity natural gas use. Under the State Unconstrained (BB1-4) scenario, energy system costs are dominated by the costs to the utilities and to participants of the additional state energy efficiency programs, which are estimated to cost about $560 billion (in present value) over the period from 2017 through 2031. The reduction in electricity demand over the period 2017 through 2031 results in a net decrease in production costs to meet electricity load that has a present value in 2014 of about $209 billion; this partially offsets the investment costs of the energy efficiency programs. Higher gas prices are part of the higher cost to serve load, but they also affect consumers who purchase natural gas for non-electricity energy services; the higher consumer cost for direct consumption of natural gas adds another $15 billion to the present value of the

CPP over the years 2017-2031. The net result is that energy system costs would be greater by about $366 billion in present value terms over the period from 2017 through 2031 under the State Unconstrained (BB1-4) scenario.

Table 5. Energy System Costs of State Unconstrained (BB1-4) and State Constrained (BB1-2) Scenarios

	State Unconstrained (BB1-4)	State Constrained (BB1-2)
Present Value (Billion 2013$)		
Cost of Electricity, Excluding EE	-$209	$335
Cost of Energy Efficiency	$560	$0
Cost of Non-Electricity Natural Gas	$15	$144
Total Consumer Energy Costs	$366	$479

Note: Present value is from 2017 through 2031, taken in 2014 using a 5% real discount rate
Source: NERA (2014b) Figure ES-2

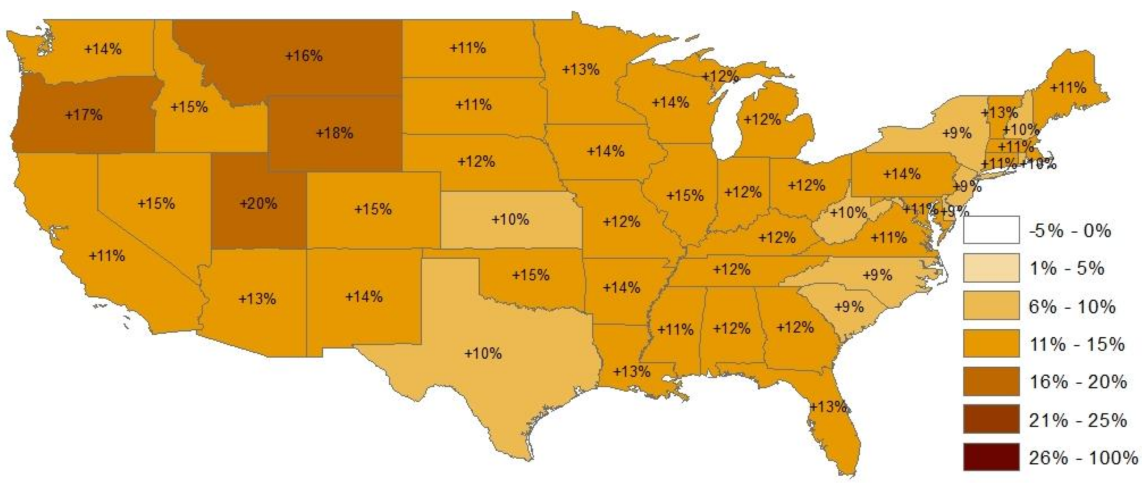
State Electricity Price Impacts of the Clean Power Plan

State delivered electricity prices would be affected by the CPP in various ways. One element is the upfront utility cost of end-use energy efficiency, which was assumed to be one-half of the total program cost of energy efficiency in both EPA's RIA analysis and our analysis. We treated the utility cost as a utility expense that is reflected in prices in the same year in which it is incurred. The consumer's half of the energy efficiency cost was *not* reflected in our delivered price estimates.

Energy efficiency programs tend to increase delivered prices for two reasons. First, as noted, the upfront utility costs of energy efficiency programs are recovered through delivered prices on remaining generation in the year they are incurred. Second, fixed transmission and distribution costs are spread over fewer electricity sales (because energy efficiency reduces end-use electricity sales). These increases can be offset somewhat by decreases in wholesale and capacity prices due to reduced electricity demand.

Figure 5 shows electricity price estimates (averaged over all sectors) for the State Unconstrained (BB1-4) scenario by state. The lowest state price impacts were estimated in the East Central and Northeast parts of the country, and the highest price increases were estimated in the Northwest. But virtually all of the predicted state electricity price impacts are substantial, with 44 states projected to experience annual average electricity price increases of 10 percent or more over the period from 2017 to 2031.

Figure 5: State All Sectors Delivered Electricity Price Impacts of State Unconstrained (BB1-4) Scenario (Annual Average, 2017-2031)



Source: NERA (2014b) Figure 17

Table 6 shows changes in average (2017 through 2031) electricity-related consumer costs by ratepayer class (residential, commercial, industrial, and averaged over all sectors) for the two scenarios. These costs are composed of electricity bills and the consumer cost of energy efficiency. The electricity bills component is calculated from delivered electricity prices and electricity sales and includes the utility program cost of any end-use energy efficiency (passed on to end users through higher electricity rates). Bills reflect both higher prices on electricity and, in the State Unconstrained (BB1-4) scenario, lower electricity demand due to energy efficiency reducing generation needs. When the consumer share of energy efficiency costs is included, total electricity-related costs in the State Unconstrained (BB1-4) scenario increase by an average of $34 billion per year from 2017 through 2031 across all sectors. Residential and commercial consumers have much larger increases in costs than industrial consumers in this scenario primarily due to lower energy efficiency use in the industrial sector than the other two sectors.

Table 6. Consumer Electricity-Related Cost Impacts of State Scenarios (Annual Average, 2017-2031, billion 2013 dollars)

	Residential	Commercial	Industrial	All Sectors
Baseline	$192	$161	$85	$439
State Unconstrained (BB1-4)				
Electricity Bills	$195	$164	$84	$443
Consumer Energy Efficiency Costs	$13	$13	$4	$29
Total Consumer Electricity-Related Costs	$207	$177	$88	$472
Change from Baseline	+$15	+$15	+$3	+$34
% Change from Baseline	+8%	+9%	+3%	+8%
State Constrained (BB1-2)				
Electricity Bills	$210	$179	$98	$487
Consumer Energy Efficiency Costs	$0	$0	$0	$0
Total Consumer Electricity-Related Costs	$210	$179	$98	$487
Change from Baseline	+$18	+$18	+$13	+$48
% Change from Baseline	+9%	+11%	+15%	+11%

Source: NERA (2014b) Figure 19

Committee on Oversight and Government Reform
Witness Disclosure Requirement – "Truth in Testimony"
Required by House Rule XI, Clause 2(g)(5)

Name: DAVID HARRISON

1. Please list any federal grants or contracts (including subgrants or subcontracts) you have received since October 1, 2012. Include the source and amount of each grant or contract.

NONE

2. Please list any entity you are testifying on behalf of and briefly describe your relationship with these entities.

NONE. TESTIFYING ON MY OWN BEHALF

3. Please list any federal grants or contracts (including subgrants or subcontracts) received since October 1, 2012, by the entity(ies) you listed above. Include the source and amount of each grant or contract.

NONE

I certify that the above information is true and correct.

Signature: [signature]

Date: 2/20/2015