

**Prepared Statement of  
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at a Hearing on  
“Innovative Practices to Create Jobs and Reduce Pollution”  
by the  
Subcommittee on Green Jobs and the New Economy  
Committee on Environment and Public Works  
United States Senate  
Washington, D.C.**

**October 13, 2011**

Mr. Chairman and Members of the Committee:

Thank you for your invitation to participate in today’s hearing. I am Anne E. Smith, and I am a Senior Vice President of NERA Economic Consulting. I am a specialist in the analysis and design of cost-effective policies, which was a core element of my Ph.D. thesis at Stanford University in economics. I have performed work in the area of air quality benefit-cost analysis and economic impact analysis over the past thirty years, including as an economist in the U.S. Environmental Protection Agency’s Office of Policy, Planning, and Evaluation, as a consultant to the EPA’s Air Office, and in many consulting engagements since then for government and private sector clients globally. I have also served as a member of several committees of the National Academy of Sciences focusing on management of risks from environmental contamination. I have analyzed costs, risks and benefits of many key U.S. air policies, including fine particulate matter, ozone, mercury and other air toxics, regional haze, NO<sub>2</sub>, SO<sub>2</sub>, and greenhouse gases.

The topic of today’s hearing is the potential impacts on jobs of environmental regulations. I have analyzed the employment impacts of many different types of regulations over the years, but I would like to focus my testimony today on our recent analyses and research related to environmental regulations affecting the electric power sector. I am a co-author of a recent study that evaluated the cumulative energy and economic impacts of four major environmental regulations affecting the electric utility sector.<sup>1</sup> I thank you for the opportunity to share our findings. My written and oral testimonies reflect my own opinions and do not necessarily represent the position of NERA Economic Consulting or any of its clients.

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<sup>1</sup> Harrison, David, Andrew Foss, James Johndrow, Eugene Meehan, Bernard Reddy and Anne Smith, *Potential Impacts of EPA Air, Coal Combustion Residuals, and Cooling Water Regulations*, report prepared for American Coalition for Clean Coal Electricity, September 2011.  
[http://www.americaspower.org/sites/default/files/NERA\\_Four\\_Rule\\_Report\\_Sept\\_21.pdf](http://www.americaspower.org/sites/default/files/NERA_Four_Rule_Report_Sept_21.pdf)

## Motivation for the Study: Fill a Gap in Information on the Cumulative Energy and Economic Impacts of Environmental Regulations

A key motivation for the study was to fill a gap in information on the combined energy and environmental impacts of environmental regulations. The U.S. Environmental Protection Agency (EPA) typically proposes regulations individually and provides estimates of each one's social costs and benefits (and other impacts) individually. That is, while EPA's analyses generally include previously-promulgated regulations in the baseline of its regulatory impact analyses, it does not usually consider the implications of other potential future regulations that are simultaneously under consideration. This can create a gap in the insights that the analysis can identify, particularly when there may be interactions between the new regulation in question and one or more other likely future regulations.

There has been concern with just such a gap in the understanding of the impacts of regulations presently facing the electricity generating sector of the U.S., of which there are quite a few, including the just-promulgated Cross-State Air Pollution Rule (CSAPR), the Electric Generating Unit MACT rule, and major regulations to address coal combustion residuals (CCR), and regulation of cooling water intake structures under Section 316(b) of the Clean Water Act. Each of these regulations increases future costs for coal-fired power plants, and they will inevitably – in combination – affect utility decision making about whether to keep retrofitting more controls, or to retire certain units. Thus, these regulations must be analyzed in a combined, or *cumulative*, manner in order to provide a credible assessment of their overall costs, energy market impacts, and macroeconomic impacts. Providing that missing cumulative assessment of the macroeconomic impacts of these four rules was the central purpose of our analysis.<sup>2</sup>

In addition, in recent years policymakers have taken interest in additional impact of environmental regulations that is not part of the classical analyses of benefits and costs that are included in regulatory analyses: “green jobs.” Some studies have noted that environmental mandates will increase employment in pollution control and clean technology sectors.<sup>3</sup> However, other researchers, including myself, have noted that these results ignore the jobs lost in the rest of the economy due to other impacts of the

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<sup>2</sup> Several other studies have analyzed these rules, but have focused instead only on whether these regulations pose reliability concerns. These studies include the following: Bipartisan Policy Center. *Environmental Regulation and Electric System Reliability*. Washington, D.C.: 2011; Brattle Group. *Potential Coal Plant Retirements Under Emerging Environmental Regulations*. Cambridge, MA: 2010; Charles River Associates. *Prospects for an EPA-Driven Capital Crisis for Utilities*. Boston, MA: 2010; Edison Electric Institute. *Potential Impacts of Environmental Regulation on the U.S. Generation Fleet*. Report prepared by ICF International. Washington, D.C.: 2011; ICF International. *Clean Air, Ash and Water Regulations: Potential Impact of EPA Proposed Rules*. Fairfax, VA: 2010; M.J. Bradley & Associates and Analysis Group. *Ensuring a Clean, Modern Electric Generating Fleet while Maintaining Electric System Reliability*. Concord, MA: 2011; and North American Electric Reliability Corporation. *Special Reliability Scenario Assessment: Resource Adequacy Impacts of Potential U.S. Environmental Regulations*. Princeton: 2010.

<sup>3</sup> See Ceres. *New Jobs—Cleaner Air: Employment Effects Under Planned Changes to the EPA's Air Pollution Rules*. Report prepared by the University of Massachusetts Political Economy Research Institute. Boston: February 2011.

regulations, including increased electricity and other energy prices.<sup>4,5</sup> Our recent analysis also sheds light on the mix of job impacts from these regulations, including the potential increase in “green jobs” and the net impacts on jobs in general.

## **Objectives and Methodology of the Study**

Our study develops a set of models to evaluate the potential effects of certain environmental regulations on energy markets and economic activity. This methodology thus complements those that have been developed to estimate the costs and benefits—and other impacts—of individual regulations.

Specifically, our study provides projected effects over the period from 2012 to 2020 of four environmental regulations affecting the electric utility sector—the final Cross-State Air Pollution Rule (CSAPR) and proposed regulations for Utility MACT), coal combustion residuals (CCR), and regulation of cooling water intake structures under Section 316(b) of the Clean Water Act—in three major areas:

1. *Coal unit retirements and retrofits.* These are estimates of the effects of potential total retrofit costs on the decisions regarding coal unit retirements.
2. *Electricity and other energy market impacts.* These impacts include the potential effects on energy markets—including coal, natural gas, and electricity—as well the increased technologies to achieve compliance and overall compliance costs.
3. *Economic impacts.* These effects include impacts on the U.S. economy, including employment, gross domestic product (GDP), and disposable personal income (i.e., personal income after taxes).

The modeling framework begins with a set of detailed estimates of the likely compliance technologies—and the costs of retrofitting them—associated with the individual regulations. These assessments are based upon the requirements of the individual regulations, including taking into account the potential flexibility provided under CSAPR.<sup>6</sup> For the CCR and Section 316(b) regulations, we use EPA estimates of retrofit costs for the various affected units. The result is a set of estimates of the potential technologies and costs to individual electricity generating units under the four policies.

The next task is to estimate the effects of these projected costs on future retirements of coal-fired power plants. The retirement model we develop is a Monte Carlo uncertainty

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<sup>4</sup> Smith, Anne E. “CRA Analyses of Federal Bills,” presented at Nicholas Institute for Environmental Policy Solutions Workshop on Estimating Employment Impacts of Energy and Environmental Policy: Lessons Learned and Future Directions, October 8, 2010 (<http://nicholasinstitute.duke.edu/envenergy>).

<sup>5</sup> Montgomery, W. David. Prepared Testimony of W. David Montgomery, Ph.D., before the Senate Committee on Environment and Public Works, Subcommittee on Green Jobs and the New Economy. February 15, 2011.

<sup>6</sup> The implications of the emissions trading provisions of CSAPR for technology choices at individual units are developed through an initial run of the NEMS model (a model that is described in the text).

model designed to predict potential economic retirements based upon comparisons of the future costs of the coal-fired unit in comparison to the costs of the likely new generation that would be added in the future. The model incorporates uncertainties in key parameters affecting this comparison, including control costs and electricity and fuel (notably natural gas) prices; the model also takes account of the feedback effects of coal unit retirements on electricity and fuel prices.

The estimated coal unit retirements and the estimated compliance costs for non-retiring units are then input to the U.S. Department of Energy’s National Energy Model System (NEMS) model, a well-established modeling framework used by the Energy Information Administration (EIA) to evaluate energy and environmental policies. To develop estimates of changes in employment and other economic impacts, the NEMS results are input to the Policy Insight Plus model developed by Regional Economic Models, Inc. (“REMI PI+”), a model used extensively by numerous government agencies and private groups to assess the economic impacts of public and private policies.

Although we have attempted to develop comprehensive assessments, the results should be viewed as subject to uncertainties beyond those incorporated in the analyses. Projected coal unit retirements, for example, do not include the effects of other potential regulatory requirements—for example, those related to greenhouse gases—and the impacts do not include potential effects of coal unit retirements on (or constraints related to) electricity system reliability. These omitted factors could lead to additional impacts beyond those projected in this study.

## **Overview of Study Results**

I summarize the results of the study in the three major areas noted above.

### **1. Coal Unit Retirements and Remaining Retrofit Requirements**

The potential retrofit costs of the four policies, when considered from a cumulative perspective, are estimated to lead to 39 gigawatts (GW) of prematurely retired capacity by 2015 among the current coal-fired power plants. This estimate represents additional retirements above those in the reference case (i.e., retirements predicted without the four regulations in place) and accounts for about 12 percent of the 2010 U.S. coal-fired electricity generating capacity.<sup>7</sup> As noted, this projection does not include the potential effects of other requirements or concerns related to detailed electricity system reliability.

The retrofit control technologies that would need to be put in place in order for non-retiring units to comply with the four environmental regulations are large. In comparison to the reference case, we estimate that the following additional controls would need to be put in place to meet the two air emission regulations: 13 GW of wet scrubbers, 53 GW of

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<sup>7</sup> This level of retirements is estimated in the retirement model and is not influenced by utility retirement announcements.

dry scrubbers, 13 GW of selective catalytic reduction (SCR), 171 GW of activated carbon injection (ACI), 163 GW of fabric filters, and 12 GW of dry sorbent injection (DSI). These estimates of the amount of capacity that will need to be retrofitted after accounting for units projected to retire instead have accounted for the flexibility provided in the regulations. Our estimates of the costs of these retrofits are based upon the costs that EPA has developed for the various technologies.

Our energy and economic impact analyses assume that all of these retrofits and retirements can be effectuated by 2015, and that the costs would not increase to response to difficulties that might be encountered in installing these technologies in such a limited time frame. We believe there is a risk that his tight timetable for retrofits cannot realistically be met, but we have not performed the requisite studies to assess what rate of combined retrofitting and retirements is viable. We do note, however, that if our assumption that all of these changes can occur during this brief period of time is unrealistic, then the energy and economic impacts of the regulations will be greater than projected in our analyses, as summarized below (assuming the regulations will be imposed on their currently proposed schedules).

## **2. Energy Market Effects**

As noted, the energy market impacts of the various regulations were estimated using the National Energy Modeling System (NEMS) model based on estimates of the coal units that retire and the compliance costs for units that do not retire. The NEMS output includes estimates of overall compliance costs for the electric sector, as well as detailed impacts on energy markets. Table 1 summarizes the potential costs for the electricity sector based on the level of coal retirements predicted in the retirement model. These costs include compliance costs for coal units that do not retire, capital costs for new capacity that would replace retiring coal units, and changes in fuel costs. Costs are projected to be approximately \$21 billion (in 2010\$) per year over the period from 2012 to 2020. The costs represent a total of \$127 billion (present value in 2010\$ as of January 1, 2011) over the period from 2012 to 2020. Capital costs for environmental controls and replacement capacity are about \$104 billion.<sup>8</sup>

The retirement of coal units and construction of replacement capacity affect electricity sector fuel consumption, fuel prices, and electricity prices. Table 2 summarizes the average potential energy market effects of the four regulations from 2012 to 2020. The report provides information on the annual effects for 2012-2020, with effects that are both higher and lower than these average values.

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<sup>8</sup> Capital costs exceed the total for environmental controls and replacement capacity because of net reductions in operating and maintenance costs.

**Table 1. Electricity Sector Costs, 2012-2020 (billion 2010\$)**

	<b>Annual Avg</b>	<b>PV</b>
Environmental Controls	\$15	\$89
Replacement Capacity	\$2	\$11
Fuel	\$5	\$28
Total	\$21	\$127

Note: Compliance costs from 2012 through 2020 are discounted to January 1, 2011 using a real annual discount rate of 7 percent.

Annual average costs are based on the present values and discounting.

The cost of environmental controls includes net cost savings for operating and maintenance (O&M) expenses.

Source: Table ES-1 in Harrison, David, Andrew Foss, James Johndrow, Eugene Meehan, Bernard Reddy and Anne Smith, *Potential Impacts of EPA Air, Coal Combustion Residuals, and Cooling Water Regulations*, report prepared for American Coalition for Clean Coal Electricity, September 2011.

**Table 2. Average Annual Energy Market Impacts, 2012-2020**

	<b>Coal Retirements</b>	<b>Coal-Fired Generation</b>	<b>Coal Price at Minemouth</b>	<b>Gas-Fired Generation</b>	<b>Gas Price at Henry Hub</b>	<b>Avg Retail Elec Price</b>
	(GW)	(million MWh)	(2010\$/ton)	(million MWh)	(2010\$/MMBtu)	(2010\$/MWh)
<b>Average of 2012-2020 Projections</b>						
Reference	3.1	1,911	\$33.54	639	\$4.48	\$86.87
CSAPR+MACT+CCR+316(b)	42.2	1,699	\$31.61	765	\$4.95	\$92.52
<b>Change from Average of 2012-2020 Reference Projections</b>						
CSAPR+MACT+CCR+316(b)	+39.1	-212	-\$1.93	+126	+\$0.48	+\$5.65
<b>% Change from Average of 2012-2020 Reference Projections</b>						
CSAPR+MACT+CCR+316(b)	+1241%	-11.1%	-5.7%	+19.7%	+10.7%	+6.5%

Note: Coal retirements are cumulative from 2010 through 2020.

Source: Table ES-2 in Harrison, David, Andrew Foss, James Johndrow, Eugene Meehan, Bernard Reddy and Anne Smith, *Potential Impacts of EPA Air, Coal Combustion Residuals, and Cooling Water Regulations*, report prepared for American Coalition for Clean Coal Electricity, September 2011.

Coal-fired generation is projected to decrease by an average of 11.1 percent over the period from 2012 to 2020. The reduction in coal demand is projected to decrease coal prices by 5.7 percent on average. In contrast, the regulations are predicted to increase natural gas-fired generation by 19.7 percent on average over the period and increase Henry Hub natural gas prices by 10.7 percent on average. The increases in natural gas prices would lead to an estimated average increase in costs of about \$8 billion per year for residential, commercial and industrial natural gas consumers, which translates into an increase of \$52 billion over the 2012-2020 period (present value in 2010\$ as of 2011 discounted at 7 percent). Average U.S. retail electricity prices are projected to increase by an average of 6.5 percent over the period.

### 3. Economic Impacts

The potential economic impacts of the four policies were estimated using the REMI PI+ model. Table 3 summarizes the potential economic impacts. The table shows both the average annual changes over the period from 2012 to 2020, as well as the cumulative effects over the same time period. These net figures take into account jobs that would be created in some sectors as a result of spending on pollution controls (i.e., “green jobs”), as well as jobs lost due to higher electricity prices and other negative impacts. The sectors that gain are dominated by several sectors that tend to gain direct employment as a result of pollution control spending—notably machinery manufacturing and construction—and by the natural gas sector that gains from increased demand for its output on the part of the electricity sector. The sectors that lose employment include mining, reflecting the decreased demand for coal. But the bulk of the job losses are accounted for by retail trade and the many other sectors that are indirectly affected by the regulations as a result of the effects of higher electricity and natural gas prices on consumer demand and U.S. industrial competitiveness—not by the sectors such as utilities and mining that are directly affected.

**Table 3. U.S. Economic Impacts, 2012-2020**

	<b>Annual Average</b>	<b>Cumulative</b>
Employment	-183,000 jobs	-1.65 million job-years
Gross Domestic Product	-\$29 billion	-\$190 billion
Disposable Personal Income	-\$34 billion	-\$222 billion
Disposable Personal Income per Household	-\$270	-\$1,750

Note: All dollar values are in 2010\$.

The cumulative employment impact is an undiscounted sum from 2012 to 2020; the cumulative GDP and disposable personal income impacts are present values as of January 1, 2011 using a real annual discount rate of 7 percent.

Disposable personal income impacts per capita from REMI were converted to disposable personal income impacts per household based on a current average U.S. household size of 2.58 people (Census 2011).

Source: Table ES-3 in Harrison, David, Andrew Foss, James Johndrow, Eugene Meehan, Bernard Reddy and Anne Smith, *Potential Impacts of EPA Air, Coal Combustion Residuals, and Cooling Water Regulations*, report prepared for American Coalition for Clean Coal Electricity, September 2011. [Cleancoalusa.org](http://Cleancoalusa.org)

Over the period from 2012 to 2020, about 183,000 jobs per year are projected to be lost on net due to the effects of the four regulations. The cumulative effects mean that over the period from 2012 to 2020, about 1.65 million job-years of employment would be lost. As noted, these net employment losses reflect net gains in some sectors and net losses in others. Of the 70 sectors in the REMI PI+ model, sectors that would gain jobs (primarily machinery manufacturing, construction and oil and gas) account for about 55,000 added jobs per year on average, and sectors that would lose jobs (represented by retail trade and the vast bulk of the other services sectors) account for about 238,000 fewer jobs per year on average. On a cumulative basis over the period from 2012 to 2020, the sectors that would gain jobs represent about 499,000 job-years, and the sectors that would lose jobs represent about 2,149,000 job-years.

Table 3 also shows the potential near- to medium-term impacts on GDP and disposable personal income. U.S. GDP would be reduced by \$29 billion each year on average over the period, with a cumulative loss from 2012 to 2020 of \$190 billion (2010\$). U.S. disposable personal income would be reduced by \$34 billion each year on average over the period, with a cumulative loss from 2012 to 2020 of \$222 billion (2010\$). The average annual loss in disposable personal income per household is \$270, with a cumulative present value loss of about \$1,750 (2010\$) over the period from 2012 to 2020. Annual economic impacts from 2012 to 2020 are provided in the report.

## **Summary**

My testimony has focused on the potential cumulative impacts on the U.S. energy system and the U.S. economy of four major environmental regulations over the period from 2012 to 2020. A key feature of our assessment is its comprehensiveness—we include the positive effects on the economy of increased demand for pollution control equipment (so called “green jobs”) and natural gas, as well as the negative effects on the economy of higher energy prices and the need to finance increased expenditures. Our results indicate that these four regulations would have substantial impacts on the energy sector and that the net economic impacts would be negative.