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Potential Impacts of EPA Air, Coal Combustion Residuals, and Cooling Water Regulations

David Harrison, Jr., Ph.D., Senior Vice President
Anne Smith, Ph.D., Senior Vice President

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Insight in Economics™

Agenda

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- Study Objectives
- Modeling Scenario and Methodology
- Energy Market Impacts
- Economic Impacts

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Study Objectives

- Evaluate effects of four major environmental policies
  - Cross-State Air Pollution Rule (CSAPR)
  - Utility MACT (regulation of mercury and other hazardous air emissions)
  - Regulation of coal combustion residuals (CCR) under Resource Conservation and Recovery Act
  - Regulation of cooling water intake under Section 316(b) of the Clean Water Act
- Focus on cumulative energy market and economic impacts
  - Coal unit retirements
  - Compliance costs
  - Energy prices (coal, natural gas, electricity)
  - Employment and other macroeconomic measures
- Use state-of-the-art models
  - NEMS model for energy market effects
  - REMI model for economic impacts
  - NERA Monte Carlo model of coal unit retirements
- Use inputs that are sensible and comprehensive
  - Flexible implementation of regulations (e.g., CSAPR)
  - Complete assessment of impacts (e.g., positive and negative jobs effects)

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Modeling Scenario and Methodology

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Modeling Scenario: CSAPR

Policy	Emission	Compliance Assumptions
CSAPR	SO_2	Apply SO_2 caps (3.4 million tons in 2012-2013 and 2.1 million tons from 2014 onward) and allow NEMS to determine which units would need to install SO_2 control technolcgies or switch to lower-sulfur coal in the interstate cap-and-trade program (within state variability limits); in order to discourage unrealistic fuel switching in the model in 2012-2013, do not allow banking of CSAPR SO_2 allowances in those years
	NO_x	Apply NO_x caps (1.2 million tons in 2012-2013 and 1.1 million tons from 2014 onward) and allow NEMS to determine which units would need to install NO_x control technolcgies in the interstate cap-and-trade program (within state variability limits); allow banking of CSAPR NO_x allowances

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Modeling Scenario: Utility MACT

Policy	Emission	Compliance Assumptions
MACT	Mercury	Apply mercury standards in 2015 at all units and allow NEMS to determine which units would need to install ACI, fabric filters, and/or scrubbers
	HCl	Assign costs for DSI in 2015 at unscrubbed units smaller than 300 MW that consume subbituminous coal (these units requiring DSI will also require fabric filters); require dry scrubbers at all non-DSI units that consume Western bituminous coal, subbituminous coal, or lignite (these units requiring dry scrubbers will also require fabric filters); require wet scrubbers at all units that consume Eastern bituminous coal (these units requiring wet scrubbers will not require fabric filters, but NEMS may retrofit them with fabric filters for mercury or they may require fabric filters for MACT PM compliance)
	PM	In addition to requiring fabric filters at all units with DSI or dry scrubbers, and in addition to requiring fabric filters (in combination with ACI) at some units for MACT mercury compliance, require fabric filters for MACT PM compliance at the necessary number of coal units so that the same percentage of total U.S. coal capacity has fabric filters in 2015 as in the EPA MACT RIA; use EPA's list of coal units installing fabric filters from the MACT RIA to identify the additional coal units that would require fabric filters

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Modeling Scenarios: CCR and 316(b)

Policy	Compliance Assumptions
CCR	Assign costs to units in 2015 based on EPA Subtitle D in initial proposal

Policy	Compliance Assumptions
316(b)	Assign costs to units in 2015 based on EPA Option 1 for impingement and 46 facilities installing cooling tower retrofits for entrainment

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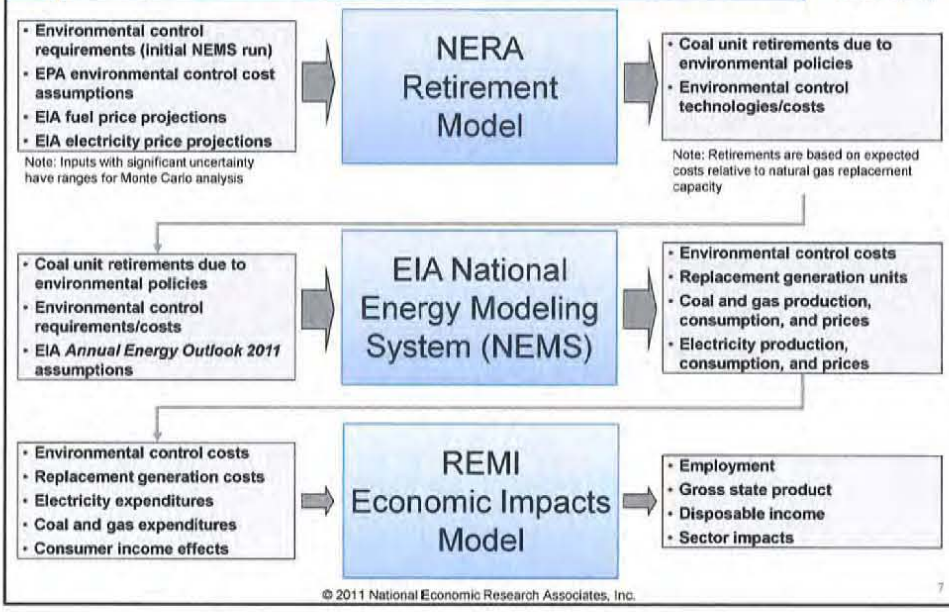
Overview of Modeling Methodology (Note: Simplification of inputs and outputs)



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Overview of Models

- NERA Retirement Model
  - Monte Carlo formulation allows for inclusion of uncertainty in key parameters (control costs, fuel prices, electricity prices) and development of ranges of costs and retirements
- NEMS
  - State-of-the-art model of the energy system
  - Used extensively by EIA and others
- REMI
  - State-of-the-art regional economic model
  - Ability to model impacts in individual states as well as U.S.
  - Used extensively by government agencies and others

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NERA Retirement Model

- The NERA Retirement Model is a Monte Carlo uncertainty model used to evaluate the potential for premature retirement of U.S. coal plants. The model is designed to mirror the decision by power companies on whether to retrofit units with environmental controls or retire them and replace them with new capacity.
- The model includes estimates of the additional costs related to environmental policies and identifies units likely to have higher future costs than potential replacement capacity. The expected future costs for coal units are based upon EIA data on unit characteristics (including capacity, capacity factor, heat rate, O&M costs, coal type, and current environmental controls) and on reference case fuel and electricity prices as well as on estimates of the additional controls and EPA information on control costs for individual technologies to comply with various environmental policies.
- The model uses statistical techniques and EPA data to simulate hourly electricity prices in each region and generation decisions by coal units and potential replacement capacity. Uncertain parameters include the costs of controls, fuel prices and electricity prices, and the costs of the likely replacement alternative (new natural gas combined cycle unit), with interactions among the uncertain parameters included in the Monte Carlo formulation. Existing coal unit remaining lifetimes are assumed to range between 10 and 20 years, depending upon unit age in 2015.
- Coal unit costs are compared with the future costs of a new natural gas combined cycle unit on the presumption that a unit would be retired if its future costs are likely to be greater than the costs of replacement capacity. The formulation accounts for market purchases during hours when coal units and the potential replacement capacity would not run. Units are presumed to retire if their expected costs are higher than the expected costs of the replacement natural gas unit

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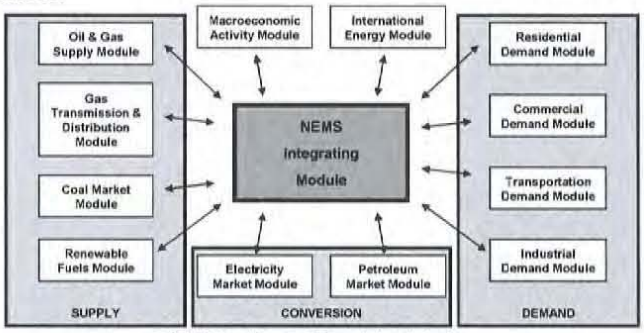
National Energy Modeling System (NEMS)

- NEMS is developed and maintained by the U.S. Energy Information Administration ("EIA") to provide projections of domestic energy-economy markets in the long term and perform policy analyses requested by decision-makers in the White House, Congress, Department of Energy, and other government agencies. These projections are also used by analysts and planners in other government agencies and outside organizations.
- For each fuel and consuming sector, NEMS balances the energy supply and demand, accounting for the economic competition between the various energy fuels and sources.



Source: EIA

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REMI

- REMI Policy Insight includes a model that has been built especially for the geographic area(s) in each customized version. The model-building system uses data from the Bureau of Economic Analysis, the Bureau of Labor Statistics, the Department of Energy, the Census Bureau, and other public sources.
- The REMI model is a structural model based on cause-and-effect relationships. The model shares two key underlying assumptions with mainstream economic theory: *households maximize utility* and *producers maximize profits*.

Source: REMI

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Energy Market Impacts

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Electricity Sector Costs (2012-2020)

	Annual Avg	PV
Environmental Controls	$15	$89
Replacement Capacity	$2	$11
Fuel	$5	$28
Total	$21	$127

Note: Costs are in billions of $2010 dollars.
Costs are calculated relative to the reference case, which includes State mercury requirements as well as implementation of the Clean Air Interstate Rue (CAIR) through 2011.
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.

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Energy Market Impacts (2012-2020)

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	Coal Retirements (GW)	Coal-Fired Generation (million MWh)	Coal Price at Minemouth (2010$/ton)	Gas-Fired Generation (million MWh)	Gas Price at Henry Hub (2010$/MMBtu)	Avg Retail Elec Price (2010$/MWh)
	Average of 2012-2020 Projections					
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
	Change from Average of 2012-2020 Reference Projections					
CSAPR+MACT+CCR+316(b)	+39.1	-212	-$1.93	+126	+$0.48	+$5.65
	% Change from Average of 2012-2020 Reference Projections					
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.

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Economic Impacts

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Comprehensive Economic Impacts

Input Category	Positive Economic Impacts	Negative Economic Impacts
Environmental control costs	More demand for manufacturing and construction	
Replacement electric capacity costs	More demand for manufacturing and construction	
Coal sales decreases		Less coal production
Coal price decreases*		Less producer surplus for coal producers
Natural gas sales increases	More natural gas production	
Natural gas price increases	More producer surplus for natural gas producers	Higher natural gas prices for residential, commercial, and industrial customers
Electricity price increases		Higher electricity prices for residential, commercial, and industrial customers
Financing of capital costs	From 2016 onward, more income to bondholders (100 percent as increased consumption)	From 2012 to 2015, crowding out of investment (50 percent of capital costs)** and reduced consumption (50 percent)

Notes: * Positive economic impacts from price effects for non-electricity uses of coal are very small and are not included in this analysis.

** Negative economic impacts due to reduced productivity from reduced private investment are not included in this analysis.

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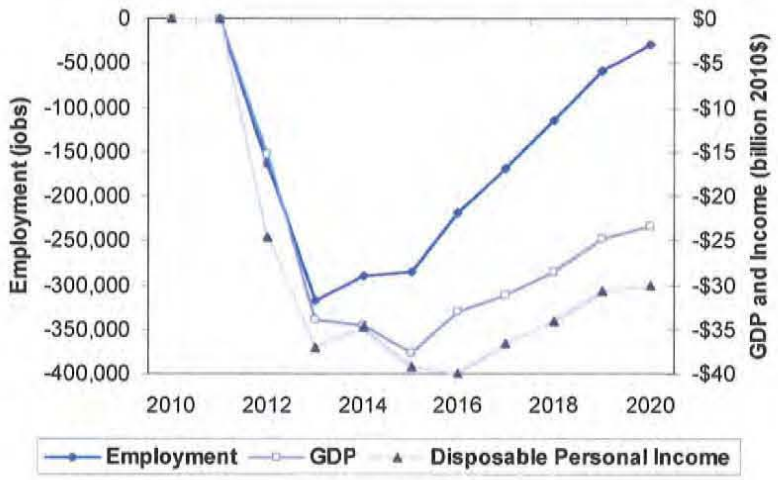
Net Economic Impacts by Year (2012-2020)



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Net Economic Impacts (2012-2020)

	Annual Average	Cumulative
Employment	-183,000 jobs	-1.65 million job-years (a)
Gross Domestic Product	-$29 billion	-$190 billion (b)
Disposable Personal Income	-$34 billion	-$222 billion (b)
Disposable Personal Income per Household	-$270	-$1,750 (c)

Note: All impacts are net impacts, i.e., reflect the net result of positive effects and negative effects
All dollar values are in 2010$.
(a) The cumulative employment impact is an undiscounted sum from 2012 to 2020
(b) 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.
(c) 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).

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Thank You

Reference:

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 the American Coalition for Clean Coal Electricity. September 2011

http://www.americaspower.org/sites/default/files/NERA_Four_Rule_Report_Sept_21.pdf

Dr. David Harrison, Jr.

Senior Vice President
NERA Economic Consulting
Boston
+1 617 927 4512
David.Harrison@nera.com

Dr. Anne Smith

Senior Vice President
NERA Economic Consulting
Washington, DC
+1 202 466 9229
Anne.Smith@nera.com

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NERA's Global Presence

25 Offices Worldwide: Over 500 Economists, Over 600 Total Staff

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David Harrison, Jr., Ph.D.

- Dr. Harrison is Senior Vice President and head of NERA's global environment practice. He has extensive experience evaluating a wide range of energy and environmental policies.
- Dr. Harrison has more than three decades of experience evaluating air quality and climate change policies, including the development of emissions trading and other market-based approaches. Dr. Harrison has assisted the European Commission and the UK government in the development of the European Union Emissions Trading Scheme. He has prepared cost-benefit and related assessments for a large number of individual sectors, including electricity, automobile, trucking, marine, chemical, iron and steel, petroleum, pulp and paper, and others.
- Dr. Harrison has directed benefit-cost analyses for numerous facilities under Section 316(b) of the Clean Water Act. These have included facilities on the major water bodies, including the Atlantic Coast, the Great Lakes, the Pacific Coast, and various rivers. These assessments have included estimates of the potential impacts on electricity cost and reliability using detailed electricity market models in various electricity regions of the United States.
- Dr. Harrison has led approximately 50 assessments of the impacts of major economic activities and policies on local, state, regional and national economic metrics, including employment, gross regional product, personal income and tax revenues. Many of these studies have related to the potential economic impacts of energy and environment policies.
- Before joining NERA, Dr. Harrison was an Associate Professor at the Kennedy School at Harvard University, where he taught microeconomics, energy and environmental policy, cost-benefit analysis, transportation policy, regional economic development, and other courses for more than a decade. He also served as a Senior Staff Economist on the U.S. government's President's Council of Economic Advisors, where he had responsibility for environment and energy policy issues. He is the author or co-author of two books on environmental policy and numerous articles on various topics in professional journals.
- Dr. Harrison received a Ph.D. in Economics from Harvard University, where he was a Graduate Prize Fellow. He holds a B.A. magna cum laude in Economics from Harvard College, where he was a member of Phi Beta Kappa, and a M.Sc. in Economics from the London School of Economics, where he was the Rees Jeffreys Scholar.

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Anne Smith, Ph.D.

- Dr. Anne Smith is an economist and decision analyst specializing in energy and environmental markets and compliance planning. Her consulting has been focused on environmental regulations analysis, environmental compliance decision making by companies, risk management of contaminated sites. Dr. Smith has made major analysis contributions on many major environmental policy issues, including global climate change and air quality standards (e.g., SO_2, NO_x, VOC, $PM_{2.5}$, mercury, visibility). Emissions trading is an area of particular expertise for Dr. Smith, including market design, analysis of market dynamics, and development of corporate strategies for responding to emissions markets.
- Dr. Smith has also been engaged in major environmental litigation, including New Source Review (NSR) litigation against several utilities, and the recent air quality nuisance suit State of North Carolina v. TVA, in which she was a central testifying expert. She has testified before the US Congress on costs of climate policy, risks of particulate matter, and regional haze. Dr. Smith also helps private corporations devise business strategies to address changing regulatory and business environments. She has particularly deep experience in electricity sector issues, including system operations optimization, pricing, compliance planning and risk management, integrated resource planning, and long-range investment planning.
- Before joining NERA, Dr. Smith headed the Climate & Sustainability Group at Charles River Associates. Prior to that, she headed the Environmental Policy Practice and served on the Board of Directors at Decision Focus Incorporated, and earlier served as an economist in the Office of Policy Planning and Evaluation at the U.S. Environmental Protection Agency.
- Dr. Smith received her BA degree in Economics from Duke University in 1977, summa cum laude, and is a member of Phi Beta Kappa. She received her MA and PhD degrees in Economics from Stanford University, where her studies concentrated in industrial organization, decision sciences, and labor economics. Her PhD degree included a minor in the Engineering-Economic Systems Department (presently known as the Department of Management Sciences and Engineering).

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