

PRISM 2.0: THE VALUE OF INNOVATION IN ENVIRONMENTAL CONTROLS

INTRODUCTION

This public brief provides a summary of a recent EPRI analysis of current and pending environmental controls on the U.S. electric power sector. Regulations covered in this analysis include those on sulfur dioxide (SO_2) and nitrogen oxides (NOx) emissions, air toxics, cooling water, and coal combustion residuals. In particular, this study seeks to evaluate the value of advanced pollution control technologies in an economically efficient framework for the power sector.

In 2009 EPRI initiated a multi-year effort to develop a U.S. energy-economic model to assess the impact of environmental, energy, and climate policies on the electric power sector, the energy system, and the economy overall at both regional and national scales. The U.S. Regional Economy, Greenhouse Gas, and Energy (US-REGEN) model is a general equilibrium model of the national economy with sectoral detail in electric power production, energy demand, and transportation. The Prism 2.0 collaborative project was initiated in late 2010 to accelerate development of the US-REGEN model and to subsequently use it to analyze critical issues for the electric sector and communicate key insights.

Similar to EPRI's earlier Prism and MERGE studies, the US-REGEN model also is used to evaluate advanced technologies and innovation. Examples of advanced pollution control technologies that, in EPRI's view, can be made commercially available in the near term as part of an accelerated demonstration and deployment effort include:

- *Advanced SCR Systems:* Enhancements to selective catalytic reduction (SCR) systems can result in increased NOx removal rates over a wider range of plant operating ranges. Advanced instrumentation and controls can optimize combustion and reduce emissions to very low levels.
- *Advanced Coal Cleaning:* Pre-treatment of coal prior to combustion can effectively remove pyrites, ash, trace metals, and other pollutant forming matter from raw fuels which in-turn, helps reduce formation of numerous emissions, such as SOx, NOx, mercury, and particulates.
- *Sorbent Activation Process:* Presently mercury control can be achieved by injecting activated carbon to bind with the mercury in flue gas, allowing removal via a fabric filter or electrostatic precipitator. A new EPRI process creates activated carbon from the coal itself, allowing considerable cost savings compared to existing methods.

ANALYSIS METHODOLOGY

The US-REGEN model uses a defined Baseline which includes the following key input assumptions:

- Economic growth and energy supply and demand based on EIA's Annual Energy Outlook 2011.¹
- Economic and electric power unit data based on 2009 and 2010 datasets, respectively, with 2010 serving as the model's base year.

¹ Energy Information Administration, U.S. Department of Energy. www.eia.gov/forecasts/aeo/

• Electric sector policies which include state renewables portfolio standards as of December 2011, the Cross-State Air Pollution Rule (CSAPR)², but no specific state or federal CO₂ regulations³, however, new coal plant additions are limited to units currently under construction.

To study the potential impact of current and pending environmental regulations on the existing generation fleet, EPRI derived two sets of additional unit-specific cost estimates for the installation of pollution controls necessary to meet the following current or proposed EPA rules:

- Mercury and Air Toxics Standard (MATS) Rule⁴ with compliance by 2015.
- Clean Water Act (CWA) 316(b)⁵ for Cooling Water Intake Structures with compliance by 2018. This was modeled as requiring closed-cycle cooling on facilities with intake flow of greater than 125 million gallons of water per day.
- Resource Conservation and Recovery Act (RCRA) regulation on Coal Combustion Residuals (CCRs)⁶ with compliance by 2020. This rule was modeled regulating coal ash under subtitle D of RCRA or as non-hazardous wastes.
- Updated National Ambient Air Quality Standards (NAAQS)⁷ on SO₂ and NOx by 2018.

The two sets of estimated retrofit investment costs, in terms of dollars per kilowatt (\$/kW), are designed to cover a range and serve as a sensitivity analysis on costs and technology innovation (Figure 1).

- The Current (High) Course maintains the standard compliance periods for the current and pending environmental regulations described above, limits policy flexibility to choose low-cost technologies, and also includes an additional market escalation cost due to the high demand for the required retrofits in a shorter period of time.
- The Alternate (Flex) Path which achieves the same level of overall compliance, e.g., reductions in emissions rates, with an extra two years to phase in, but assumes technology innovation and system optimization, less stringent aquatic entrainment controls, less retrofit cost escalation, and a more phased implementation for NOx and air toxics regulations.

 $^{^2}$ CSAPR aims to reduce SO₂ emissions by 73 percent and NOx emissions by 54 percent from 2005 levels by 2015. http://www.epa.gov/airtransport/

³ Neither the Regional Greenhouse Gas Initiative (RGGI) nor the California Assembly Bill B 32 are included. Federal Clean Air Act regulations addressing greenhouse gases are also not included.

⁴ MATS rule and information are posted at: http://www.epa.gov/mats.

⁵ CWA 316(b) proposal and information are posted at: http://water.epa.gov/lawsregs/lawsguidance/cwa/316b/

⁶ RCRA for CCRS rule is at http://www.epa.gov/osw/nonhaz/industrial/special/fossil/ccr-rule/index.htm

⁷ For information on the NAAQS, see http://www.epa.gov/ttn/naaqs/standards/so2/s_so2_index.html

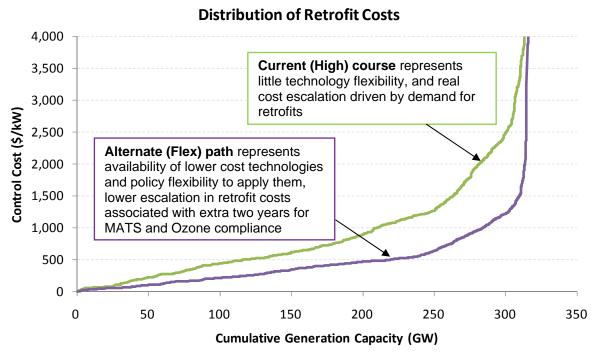


Figure 1. Range of Retrofit Costs

ANALYSIS RESULTS

The two sets of estimated retrofit costs were used as inputs to the US-REGEN model to assess the potential impacts of current and pending environmental controls the on the electric power sector and the U.S. economy out to 2035. The model can incorporate these additional costs of future operation, and estimate the likely changes in unit dispatch, net revenue, and profitability, enabling an informed decision on whether to retrofit each unit with the required pollution controls or retire the unit.

As US-REGEN is a full macroeconomic model of the U.S. economy, it also captures the effect of these added pollution control costs on the power sector in terms of changes in electricity generation, capacity, expenditures, and electricity prices. Broader economy-wide impacts estimated include changes to natural gas prices and a decrease in economic output due primarily to higher energy prices and the required additional expenditures in the power sector.

Figure 2 illustrates the changes in the coal generation fleet due to the impact of the environmental controls costs under the Current (High) Course by 2020. Notably, approximately 202 GW of existing coal capacity remains financially viable with payback times of less than 5 years on the required environmental investment. Another 61 GW of coal capacity – primarily the older, smaller, less efficient units – would not see profitability if the required environmental controls were installed and therefore are retired instead of retrofit. The remaining 54 GW of coal capacity will be either retired or retrofit depending on a number of market-specific factors: whether cost recovery can be obtained (if regulated), what other units in their region do and how the power market prices change (if competitive), whether demand for electricity is flat or increasing, what natural gas fuel costs are, etc.

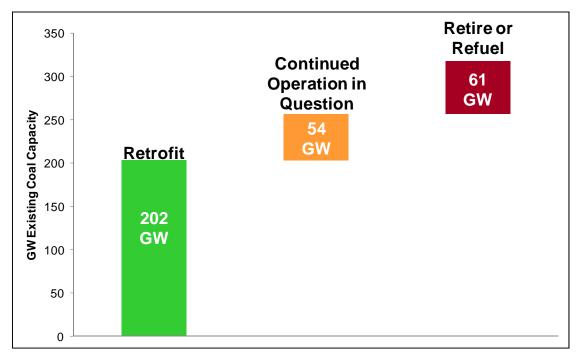


Figure 2. Uncertainty in Unit Retrofits: Current High Course (2020)

In the Alternate (Flex) Path, the reduction in retrofit cost escalation, combined with the availability of the advanced control technologies, enables a greater number of the existing coal units to comply with the regulations while maintaining profitable operations. Compared to the 202 GW of retrofits in the Current (High) Course, 288 GW of retrofits occur in the Alternate (Flex) Path. Far fewer units are forced to retire or switch fuels (25 GW compared to 61 GW) and even fewer units are subject to the uncertainty of whether continued operations will be economic subject to other market factors (4 GW versus 54 GW). As a result, the Alternate (Flex) Path results in less uncertainty as to whether units will retire or retrofit, and a greater persistence of the low-cost coal generation that is the backbone of our power system even as we meet the desired environmental outcomes. In addition, the value to the overall economy in pursuing the Alternate Path versus the Current (High) Course is estimated to be about \$100 billion, in present value terms over 25 years.

Another critical factor to consider in the outlook for the power sector, in light of current and pending environmental controls, is the expectation on the price of natural gas. EPRI's analysis indicates that with a lower projected price by 2020 of about \$4/mill Btu for power producers, just over 100 GW of coal-fired generation (1/3 of the existing fleet) could be retired. A flexible path for compliance strategies, with lower fixed costs, would still reduce this impact.

A summary of the economic impacts of the current and pending environmental controls is presented in Table 1. The difference in all the economic indicators is due to the significant potential for innovation and optimization in emissions control technology including the ability to deploy low-cost technologies. For additional details on the analysis and the US-REGEN model go to http://globalclimate.epri.com.

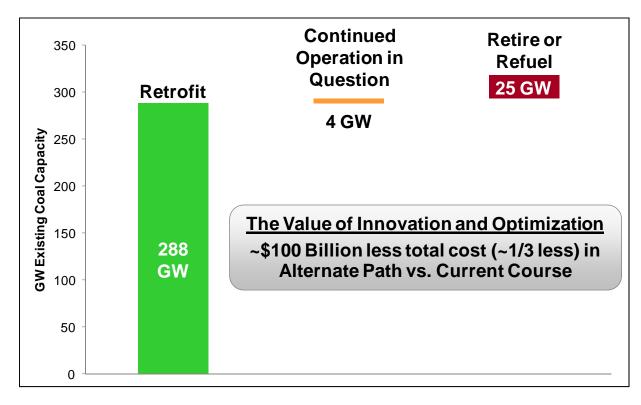


Figure 3. Reducing Uncertainty: Alternate Flex Path (2020)

Table 1: Summary Economic Results from Current and Pending Environmental Controls on the U.S.			
Electric Power Sector (incremental to the baseline)			

Annualized Power Sector Expenditures 2010-2035 ⁸	Power Sector Expenditures (present value 2010-2035) ⁸	Retail Price Impacts (national average)	Economy-wide Impacts ⁹ (present value 2010-2035)
\$10 to \$16 billion for retrofits, new capacity, incremental fuel/O&M	\$140 to \$220 billion for retrofits, new capacity and fuel/O&M	4.5% - 8% in 2015 3.8% - 6.5% in 2020	\$175 to \$275 billion

Source: US-REGEN model "Analysis of Current and Pending Environmental Controls on the U.S. Electric Power Sector", see <u>http://globalclimate.epri.com</u>

⁸ A real discount rate of 5 percent is used in these calculations.

⁹ Economy-wide impacts do not include estimates for health or environmental benefits resulting from the regulations.

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