Avoiding a Train Wreck: Replacing Old Coal Plants with Energy Efficiency

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EXECUTIVE SUMMARY

Changes in fossil fuel markets and updates to environmental regulations are putting increased pressure on the competitiveness of existing coal-fired electric power plants. These changes put on the order of 40,000 megawatts of coal-fired electric generation at risk of retirement. This capacity is primarily located in the Ohio Valley, Upper Midwest, Mid-Atlantic, and Southeast where coal is the dominant generation fuel. Most of these units are older, less-used plants rather than the more modern units that have already had their emissions control systems upgraded.

Whether these coal plants are retired and replaced, or have additional environmental measures installed to bring them into compliance with updated regulations, utilities will need to make a significant investment. These investments will raise electricity rates for customers. In many affected markets, electric rates are projected to increase by more than 20 percent in the next few years.

An alternative to these supply-side investments would be to look at customer-side investments in energy efficiency to replace this capacity, in particular, combined heat and power (CHP) and waste energy recovery. Energy efficiency and CHP are typically less expensive energy resources than coal power plant retrofits or construction of new natural gas generation. As a result, impacts on electricity rates would be minimized, benefiting all utility customers, with many customers having the added benefit of seeing their energy bills decline as their consumption declines. Moreover, this strategy of using energy efficiency to enable retirement of older coal plants would help reduce the risk of future costs likely to be incurred by coal-fired electricity generation, such as a cost for carbon emissions.

A key target for these energy efficiency investments should be large energy consumers, particularly manufacturing firms, many of whom are poised to make major new capital capacity investments in their facilities as the economy recovers and demand for manufactured products increases. These investments in manufacturing have the added benefit of modernizing energy-using infrastructure in ways that offer additional local economic benefits of job creation and enhanced environmental compliance of the manufacturing facilities.

Unfortunately, while customer-side investments represent a least-cost path for maintaining electricity supply requirements, current utility regulatory and business models do not encourage utilities to make these investments. To realize the full economic benefits of energy efficiency will require a change in the utility regulatory business model to encourage utilities to shift a large portion of their investments from the supply-side to the demand-side. This shift will require changes that encourage utilities to invest ratepayer funds in the demand-side and allow them to earn a preferred return on these investments. If these policies are put in place, customers will benefit from lower electricity rates and a more vibrant local economy with more jobs, while electricity utilities will be motivated to become energy efficiency suppliers, not just electricity suppliers.

It has often been observed that crisis and opportunity are inextricably linked, as a crisis encourages us to push the envelope of innovation and accomplish feats we didn't think we were capable of. The so-called "coal train wreck" may afford just such an opportunity to modernize our electric utility regulations to reflect a new century of different economic and energy markets, creating opportunities for the utility industry to define a new path to sustained profitability by selling efficiency services not just electricity, while ensuring reliable and affordable power to their customers.

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Please note that co-author Rachel Gold, formerly with ACEEE, is now with OPower.

INTRODUCTION

For the past century, America has relied upon coal-fired power plants as the primary source of electricity generation. Updates to U.S. Environmental Protection Agency (EPA) regulations will require that investment be made in these plants to allow their continued operation. These combined market conditions call into question the economics of further investment in many of these older coal power plants to allow their continued operation. Additionally, in recent years, coal's cost advantage as a utility fuel has diminished when compared to natural gas. So, utilities are faced with the prospect of either investing to bring many coal power plants into compliance with the updated environmental regulations, or investing in new energy resources to meet customer electricity needs. The potential costs of bringing coal plants into compliance or replacing them with new, likely natural gas plants would result in significant increases in the price of electricity. Substantial uncertainty exists about the costs the industry could face, but estimates for compliance investment costs range from $70-180 billion (Celebi et al. 2010). A number of utilities including Progress Energy, Duke Energy, and American Electric Power have already made announcements of planned retirements (Mufson 2011; Wald 2009; Dayton Daily News 2011).

Regardless of whether utilities opt to retrofit old power plants or build new ones, utilities and their customers are faced with the prospect of increasing electric rates to recover the cost of these new supply investments. Energy efficiency represents an alternative resource that can replace a significant portion of the at-risk coal capacity at a fraction of the cost of supply-side investments. Maximizing cost-effective investments in energy efficiency can help ensure adequate supplies of electricity while containing the rate increases. In addition, energy efficiency investments made in the industrial sector can contribute to the modernization of our manufacturing sector, providing important benefits to local economies.

SITUATIONAL ASSESSMENT

A number of factors figure into a utility's decision about whether to retrofit or retire and replace an existing coal plant. The majority of the coal plants that may be affected by these factors are the older, more costly plants that generally are run a limited number of hours per year.

Impact of EPA Utility Regulations

EPA is proposing updates to at least six regulations affecting coal-fired power plants with compliance deadlines in the next seven years (see Table 1). The combined effects of these more stringent regulations, rather than the effect of any single regulation, will affect investment decisions by utilities as to what course to take to meet customer electricity needs.[1]

Various analyses have projected that between 6,000 and 65,000 MW of capacity could be at risk of closure in the near future as a result of the impact of these regulatory changes. Possible retirements of older power plants have raised concerns about the adequacy of supply in some regions of the country, primarily in the Midwest, Southeast, and Mid-Atlantic regions of the country (Tierney 2011). More recent analysis by ICF (2011) made after EPA had issued more details on the proposed rules suggest the impact may not be a great as some initially feared, with ICF reducing its estimates for closure from 50,000 to 40,000 MW (SNL 2011).

[1] World Resources Institute provides a good explanation of these rules on their Web site: http://www.wri.org/stories/2010/12/response-eeis-timeline-environmental-regulations-utility-industry.

Table 1. EPA Regulatory Actions Affecting Utility Coal Power Plants

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Coal Assets Face an Environmental Regulatory "Menu"

Proposed Regulation	Target Pollutants or Practices	Control Options	Status
Utility MACT (Successor to CAMR)	Hazardous Air Pollutants (HAPs or Air Toxics) such as Hg, HCl, metals, organics, others)	Baghouses; Activated Carbon Injection; Scrubbers; Sorbent Injection; Fuel Switching	Draft Regs planned March 2011 Final regs planned November 2011 Implementation within 3 years (~2015)
Clean Air Transport Rule (CATR) (Successor to CAIR)	Reduce downwind contribution to ozone and PM2.5 non-attainment via control of precursor SO_2 and NOx emissions	Scrubbers; SCRs; SNCRs; Low NOx Burners; Trading? Facility Emissions Averaging?	Impacts 31 Midwestern and Eastern states Draft regs announced July 2010, comment period closed October 2010 Final regs expected Spring 2011 Implementation first phase begins 2012 with second phase in 2014
Regional Haze Program Best Available Retrofit Technology (BART)	Improve visibility in Class I areas via reduction in SO_2, NOx and $PM_{2.5}$	Scrubbers; SCRs; SNCRs; Low NOx Burners; Trading?; Retrofit on older units	Finalized in 2005; many states still need SIPs
National Ambient Air Quality Standards (NAAQS)	SO_2, NOx, $PM_{2.5}$, CO and ozone	Baghouses; Scrubbers; SCRs/SNCRs/Low NOx Burners; Oxidation Catalysts; Sorbent Injection; Fuel Switching; Offsets	New NOx and SO_2 one-hour standards finalized Revisions to $PM_{2.5}$, Ozone and CO standards pending
Solid Waste Disposal	Coal Combustion Residue (CCR)	Phase out wet surface impoundments (ash ponds); Composite liner and other design requirements for landfills.	Draft rule announced in May 2010, public comment period ended November 2010. Final rule expected in 2011. Ash pond closures 5 – 7 years after rule is finalized.
Water and Wastewater	Cooling Water Intake Design	Intake design upgrades	Cooling Water Intake: Draft regs planned Spring 2011
	Waste Water Toxic Metals	Treatment or zero discharge	Waste water: Draft regs expected mid-2012

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Source: Black & Veatch 2010

Aging Fleet

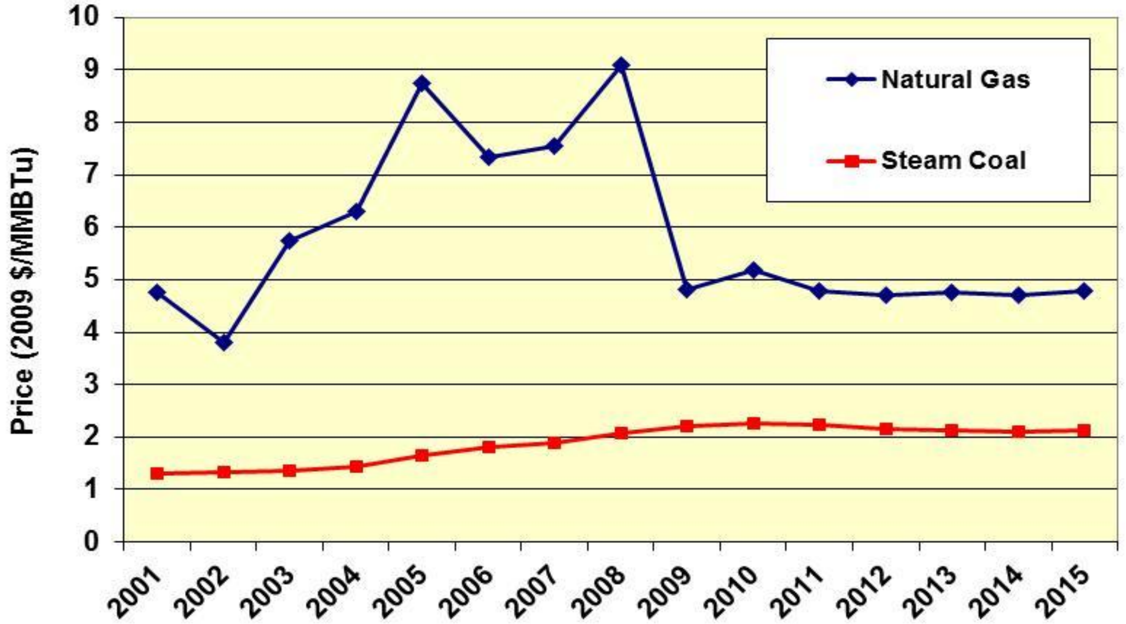
Most of the coal-fired U.S. electric generation fleet was built between the 1950s and 1980s. These coal plants were originally designed to operate for 30 years, although through-life extension measures have enabled them to operate far longer than originally anticipated. The median coal generation plant was built in 1966, and most of the existing coal capacity is over 25 years old, with the last major additions occurring in 1980–1984 (Source Watch 2011). Until recently, many of these older, smaller plants were exempted from provisions of the Clean Air Act. As a result, many of these plants have not been modernized or updated with current emissions control technologies (Hsu 2006). Many of these older plants have not seen the level of modernization investment that some of the newer plants have received, so that their cost of operation may be higher due to deferred maintenance.

Utility Fuel Prices

Compounding the challenges for electric utilities is the shift in the relative prices of coal and natural gas. During the 1990s and early part of 2000s, utilities in many regions made major investments in new natural gas capacity (Elliott 2006). Because of restructuring of the electric power industry, low gas prices at the time, and improvements in gas power plant technology, some regions of the country saw substantial investments in natural gas fire generation (CRS 2010). However, during the 2000s, natural gas prices rose dramatically and exhibited significant volatility, which made it a less attractive electric generation source.

During the latter part of the past decade, coal markets globalized and prices increased dramatically (Elliott 2006). During this same period, we saw the development of non-conventional natural gas resources, in particular, shale gas that has resulted in a dramatic reduction in natural gas prices in North America (MIT 2011). These lower and more stable prices are projected to continue into the foreseeable future (Habacivch 2011; Petak 2011). Because of its low operating cost and low emissions relative to coal, natural gas has again become a more attractive utility fuel even though the price of natural gas on a per Btu basis remains somewhat higher than coal (see Figure 1).

Figure 1. Historic and Projected Prices of Utility Steam Coal and Natural Gas



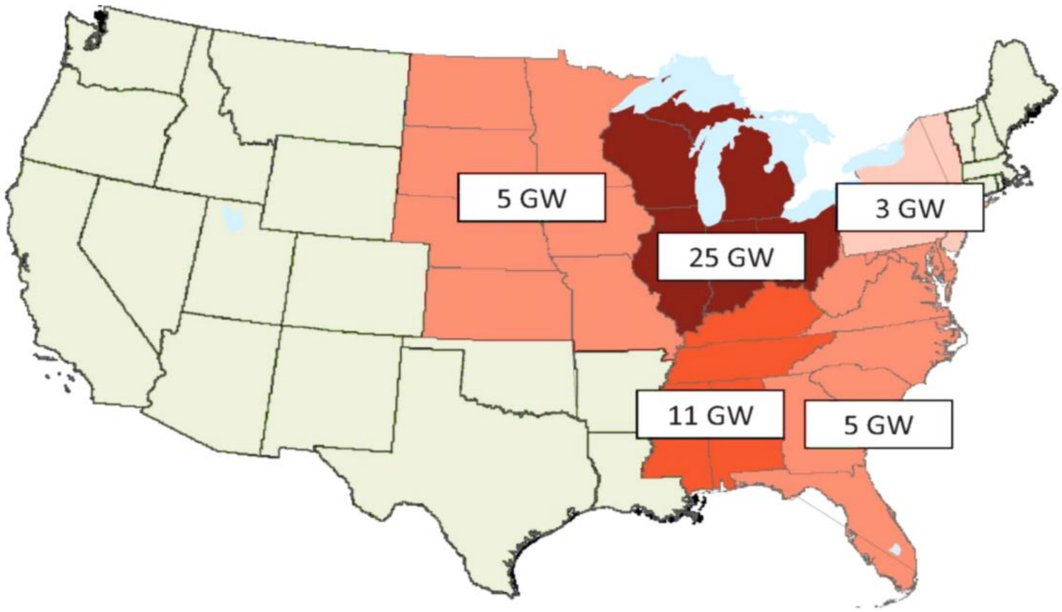
Source: EIA 2010

CAPACITY AT RISK FOR RETIREMENT

Estimates of the total capacity of electric generation at risk for retirement range from 6,000 to 65,000 MW by 2015 (most of the studies have some overlap in the range of 25,000 to 35,000 MW) (Tierney 2011). Table 2 below describes one of the major study's projections of coal plant retirements by 2015. The capacity of power plants at risk for retirement varies greatly by state. Some states in the South-Central, West, and Northeast made a major shift to natural gas during the past twenty years. In contrast, many states from the North-Central through the Midwest and into the Southeast remain dependent upon coal as a base-load fuel (CRS 2010). The potential impacts of complying with these new regulations fall predominantly on these coal-dominant states (see Figure 2). While significant natural gas capacity was constructed in these regions, it was overwhelmingly peaking capacity rather than intermediate or base-load combined cycle gas turbine (CCGT) facilities. As a result, many of these states are not in a position to shift to existing natural gas capacity, as can be done in other regions.

Most of the at-risk plants lie in the Ohio Valley, Upper Midwest, Southeast, and Mid-Atlantic, as can be seen in Figure 2, which shows one of the medium-range estimates for capacity retirements. This pattern of possible closures is preserved across all the major studies reviewed in our research. Table 2 compares the forecasted capacity at risk with actual summer capacity (EIA 2010), suggesting that the Midwest and central Southeast are the most at risk of capacity shortages.

Figure 2. "At Risk" Coal Generation by Region



Source: ICF 2010

Table 2. Forecasted Capacity at Risk by Region

State	Capacity at Risk	Total Summer Capacity	Percentage of Total Summer Capacity at Risk
Illinois, Indiana, Ohio, Michigan, Wisconsin	25 GW	152 GW	16.4%
Alabama, Kentucky, Mississippi, Tennessee	11 GW	88 GW	12.5%
Delaware, Florida, Georgia, Maryland, North and South Carolina, Virginia, West Virgina	5 GW	201 GW	2.5%
Iowa, Kansas, Minnesota, Missouri, Nebraska, North and South Dakota	5 GW	77 GW	6.5%
Pennsylvania, New York, New Jersey	3 GW	103 GW	2.9%

Source: capacity at risk—ICF 2010; summer capacity—EIA 2010

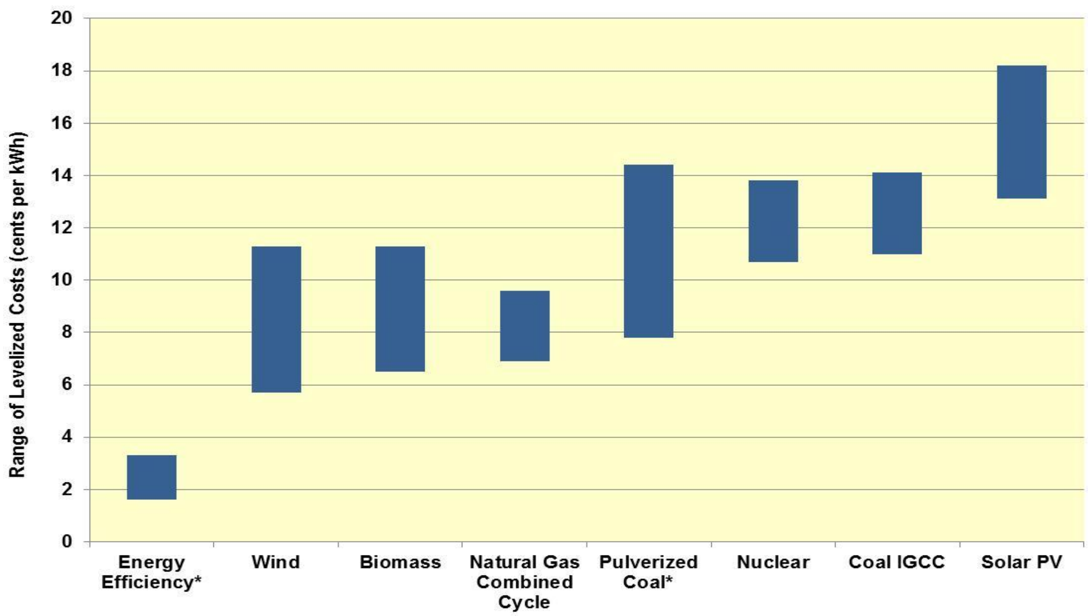
ROLE FOR ENERGY EFFICIENCY

Energy efficiency represents a low-cost energy resource that could be called upon to meet a significant portion, if not all, of the electricity capacity that could be lost due to coal plant closures. Significant energy efficiency resources are available in the at-risk states. These resources are less expensive than investments required to bring existing coal plants into compliance or to construct new generation capacity, and can be deployed much more quickly. As a result, including efficiency as part of the utility resource plans for at-risk states will minimize the costs of meeting future electricity needs.

Deploying Efficiency Resources Costs Less than Building New Coal Plants

Energy efficiency has proven to be a least-cost resource when compared with new generation capacity, and is the cheapest option for meeting our additional capacity needs. ACEEE's research has found that the average cost to a utility for energy efficiency measures is 2.5 cents per kWh, in comparison to new generation sources, which can range from 6 to 15 cents per kWh (see Figure 3) (Friedrich et. al. 2009; Lazard 2009).

Figure 3. Levelized Utility Cost of New Electricity Resources



Notes: Energy efficiency average program portfolio data from Friedrich et al. 2009 (ACEEE); all other data from Lazard 2009. High-end range of advanced pulverized coal includes 90% carbon capture and compression.

In particular, energy efficiency investments in manufacturing, including combined heat and power (CHP) and recovered waste heat, are among the lowest cost efficiency resources (Chittum, Elliott & Kaufman 2009). Investment in manufacturing has the added benefit of modernizing manufacturing plants, improving their global competitiveness and reducing their cost of complying with future industrial air quality regulations. U.S. manufacturing is poised to enter a period of major capital investment to modernize its capacity (BCG 2011), which it will need to remain globally competitive. A significant share of U.S. manufacturing is located in the states that are likely to face retirement of existing coal capacity. By directing some utility energy efficiency investments into manufacturing modernization, the U.S. can maximize the economic impact of these dollars.

States and localities that invest in efficiency profit from a range of secondary economic benefits as well. Energy efficiency investments directly reduce utility bills and operating costs for consumers. This effectively reduces dollars spent for the purchase of fuel and the costs of operating a coal plant, and redirects those dollars into new jobs in other sectors of the local economy. Most of these sectors create more local jobs than the fossil-fueled electric generating sector where significant dollars flow out of the local economy (Laitner et al. 2010). In addition, utilizing energy efficiency resources to enable the retirement of older coal plants helps reduce risk by significantly reducing the amount of future costs that ratepayers would face if a policy to impose a cost for carbon emissions was enacted.

Efficiency Can Meet Forecasted Capacity Shortfalls

Energy efficiency is a vast, untapped energy resource in the U.S. This resource can be used to meet the forecasted generation capacity shortfall. Many utilities are already factoring energy efficiency into their planning (Harris 2011; TVA 2011), and energy efficiency is recognized as a strategy for meeting capacity challenges in many of the analyses predicting the retirement of coal plants. Proactive management of energy efficiency (and “smart grid”) resources have been advanced as solutions that can ensure that electric reliability will not be compromised. One such analysis estimated that by 2018 new energy efficiency programs could decrease summer peak capacity demand by 20,000 MW of the 40,000 MW that may be needed (Bradley et al. 2010; NERC 2009). An ACEEE meta-analysis of 48 studies on the potential for energy efficiency in the U.S. indicates that given the right choices and investments, the U.S. could cost-effectively reduce energy consumption by 20 to 30% or more over the course of the next 20 years (Laitner and McKinney 2008).

Energy efficiency potential studies in a number of the at-risk states indicate a large amount of available energy efficiency. The Southeast Energy Efficiency Alliance (SEEA) analyzed the cost-effective energy efficiency potential for many of the at-risk states including all of West Virginia and parts of Alabama, Georgia, Kentucky, Maryland, Mississippi, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, and Virginia. The analysis covered four end-use sectors (residential, industrial, commercial, and transportation) and three fuel types (electricity, natural gas, and fuel oil). SEEA projected that the measures included in its study would avoid the need for approximately 60,000 MW of new capacity in the southern United States by 2030 (Brown 2010).

ACEEE has conducted state-specific studies of efficiency potential in a number of the at-risk states and found substantial opportunities to meet capacity needs with efficiency. In Ohio, cost-effective efficiency policies could reduce capacity needs by nearly 1,500 MW by 2015 and 7,600 MW by 2025 (ACEEE 2009). In Pennsylvania, the story is even better. By 2015 the state could cost-effectively reduce capacity needs by over 5,000 MW ramping up to approximately 20,000 MW by 2025 (Eldridge et al. 2009).

The untapped potential for increased efficiency savings is massive, with the projected range of available efficiency consistently falling within (or exceeding) the range of estimated capacity needed to address forecasted coal retirement. Many at-risk states have only just begun to take advantage of this resource, and there are a number of cost-effective policies these states can adopt now that will avoid constrained capacity and high electricity prices.

The states and regions most at risk are already engaged in some energy efficiency programs, with more efforts in some states than others. Table 2 lists states that are most “at-risk” for coal power plant retirement. All of the at-risk states are already meeting some capacity needs with energy efficiency. However, the savings being realized represent only a fraction of the available, cost-effective resource (Molina et. al. 2010).

Of the at-risk states, nine have an Energy Efficiency Resource Standard (EERS), which establishes targets for energy efficiency savings for the utilities in the state. These savings are targets and requirements by state legislatures and utility commissions that will require investment in energy efficiency programs by utilities. The savings from those programs are commitments from states and utilities that will help to meet capacity shortfalls. ACEEE’s recent report on EERS performance has found that states with an EERS are achieving significant energy efficiency savings from utility programs, reducing strains on the utility grid. Overall, most states are meeting or are on track to meet energy saving goals. Thirteen of the twenty states with EERS policies in place for over two years are achieving 100% or more of their goals, three states are achieving over 90% of their goals, and only three states are realizing savings below 80%

of their goals (Sciortino et al. 2011). These EERSs prioritize energy efficiency investments by utilities, allowing efficiency resources to contribute to capacity needs.

Efficiency Can Be Deployed Quickly

Capacity shortfalls could occur as soon as 2015. Energy efficiency investments can be procured relatively quickly, compared with the longer lead time required for the permitting of new power plants or transmission lines. It can take more than a decade to bring a new power plant online and any number of pitfalls can delay the project, such as the securing of financing and necessary permits, market volatility, and construction delays. In contrast, energy efficiency comes in fairly small chunks, so that investments can be spread out over time as needed.

While a number of the at-risk states have energy efficiency programs in place, most would require a rapid ramp-up to significantly contribute to mitigation of capacity constraints. ACEEE's research (Nowak et al. 2011) on states that have already deployed "rapid start" programs documents key strategies for achieving energy savings, including increasing energy efficiency program budgets, creating stakeholder groups, and focusing on commercial and industrial sectors. Although these "rapid start" states, like many of the affected states, did not have the benefit of well-established programs, they did have a large, low-cost reserve of energy efficiency opportunities because customers are less likely to have done many energy efficiency improvements.

RECOMMENDATIONS

Current utility regulatory and business models do not encourage utilities to make customer-side investments. To realize the full economic benefits of energy efficiency will require a change in the utility regulatory business model to encourage utilities to shift a large portion of their investments from the supply-side to the demand-side. This shift will require changes that encourage utilities to invest ratepayer funds in the demand-side and allow them to earn a return on these investments.

The changes in the utility regulatory business model will need to take place at the state level, since our utility regulatory system is state-led. A key element of this change in the business model is to allow utilities to make customer-side investments using ratepayer dollars and to allow a return on these dollars similar to returns they would receive when investing in supply-side resources. Typically, these returns would be in the form of performance incentives for meeting energy savings targets (Hayes et al. 2011). All customers would benefit from these investments in the form of lower electricity rates (i.e., lower rate increases than under a supply-side strategy), and a more vibrant local economy with more jobs. Electric utilities would be motivated to become energy efficiency suppliers, not just electricity suppliers.

In many ways this recommendation is a return to the foundation of utility integrated resource planning (IRP) that was introduced as a regulatory principle over three decades ago. At that time, utilities were ending a period of rapid growth in electricity demand and major capacity investments. Many stakeholder groups were expressing concerns about the cost of continuing to invest in new supply-side resources that were driving up utility rates. Regulators saw that building a portfolio of supply- and demand-side resources represented a least-cost planning solution that would insure affordable electricity.

With retirements of many of the generation assets constructed during that previous investment boom, we are again faced with a need for new capacity. A return to the principles of least cost portfolio planning represents an idea whose time has come again.

Utilities need to participate and benefit if this solution is to become a reality. In a gross simplification, utilities make profits by selling electricity and from making investments on the behalf of ratepayers on which they earn a regulated return. As a result, customer-side energy efficiency negatively impacts both these revenue streams by reducing sales and reducing the need for capital investments in capacity (Kihm 2009). A number of regulatory remedies have been proposed as part of the resource planning process, including decoupling and incentives (Hayes et al. 2011).

A dialog will need to occur among utilities, their regulators, and consumer groups, including large customers, to find a path forward that will benefit all customers and the utilities themselves. These discussions will likely be difficult because of the inertia of entrenched interests on the part of all stakeholders. However, the opportunities for customers, the local economy, the environment, and the economic future of the utility industry suggest that this topic represents a discussion that needs to be engaged in with urgency and seriousness.

SUMMARY AND CONCLUSIONS

Changes in fossil fuel markets and implementation of updated environmental regulations put on the order of 40,000 MW of coal generation at risk of retirement by utilities. This capacity is primarily located in the Ohio Valley, Upper Midwest, Southeast, and Mid-Atlantic, where coal is the dominant generation fuel. Utilities are anticipated to need to make significant investments to meet existing demand either for plant upgrades or replacement with natural gas capacity. Recovery of these utility investments will structurally raise electric rates for decades.

An alternative to these investments would be to invest in customer-side energy efficiency to replace much of this capacity. Energy efficiency and CHP are typically less expensive energy resources than are either investments in environmental compliance retrofits of older plants or construction of new natural gas-fired electric generation. The lower utility investment would mean smaller increases in future electricity rates, benefiting all customers, and many utility customers would have the added benefit of seeing their energy bills decline as their consumption declines.

A key target for these energy efficiency investments should be large energy consumers, particularly manufacturing firms, many of whom are poised to make major new capital capacity investments in their facilities as the economy recovers and demand for manufactured products increases. These investments in manufacturing have the added benefit of modernizing energy-using infrastructure that offers additional local economic benefits of job creation and enhanced environmental compliance of the manufacturing facilities.

Current utility regulatory and business models do not encourage utilities to make customer-side investments. A change in the utility regulatory business model to encourage utilities to shift their investments from the supply-side to the demand-side is needed to realize the full economic benefits of energy efficiency. This shift will require changes that encourage utilities to invest ratepayer funds in the demand-side and allow them to earn a rate of return on these investments. If these policies are put in place, customers will benefit from lower electricity rates, plus a more vibrant local economy with more jobs. Electricity utilities will be motivated to become energy efficiency suppliers, not just electricity suppliers.

To begin to realize this opportunity, a dialog among utilities, their regulators, and their customers should be initiated. Agreements will have to be reached on a state-by-state basis, because of our state-based utility regulatory system. However, because of the interconnected nature of our electric system, major customer-side efficiency investments in just some states will benefit all states in a region by taking some pressure off the need to make supply-side investment. Many challenges exist to reaching agreements, but the benefits are huge and will create a more economically and environmentally sustainable electric system, bolstering local economies.

It has often been observed that crisis and opportunity are inextricably linked, as a crisis encourages us to push the envelope of innovation and accomplish feats we didn’t think we were capable of. The so-called “coal train wreck” may afford just such an opportunity to modernize our electric utility regulations to reflect a new century of different economic and energy markets, creating opportunities for the utility industry to define a new path to sustained profitability by selling efficiency services not just electricity, while ensuring reliable and affordable power to their customers.

REFERENCES

[ACEEE] American Council for an Energy-Efficient Economy. 2009. *Shaping Ohio's Energy Future: Energy Efficiency Works.* Report E092. http://aceee.org/research-report/e092. Washington, D.C.: American Council for an Energy-Efficient Economy.

[BCG] Sirkin, Harold and Michael Zinser. 2011. *Made in the U.S.A., Again*. Boston, Mass.: Boston Consulting Group.

[Black & Veatch] Griffith, M. 2010. What Will Be the North American Energy Industry's "New Normal". http://www.bv.com/Downloads/Resources/Brochures/20101017_Webinar.pdf. Webinar: Black & Veatch.

Bradley, Michael J., Susan F. Tierney, Christopher E. Van Atten, Amlan Saha, and Carrie Jenks. 2010. *Ensuring a Clean, Modern Electric Generating Fleet while Maintaining Electric System Reliability.* Prepared for the Clean Energy Group. http://www.mjbradley.com/documents/MJBAandAnalysisGroupReliabilityReportAugust2010.pdf. Concord, Mass.: M.J. Bradley Associates.

Brown, Marilyn A., Etan Gumerman, Xiaojing Sun, Youngsun Baek, Joy Wang, Rodrigo Cortes, and Diran Soumonni. 2010. *Energy Efficiency in the South.* http://www.seealliance.org/se_efficiency_study/full_report_efficiency_in_the_south.pdf. Atlanta, Ga.: Southeast Energy Efficiency Alliance

Celebi, Metin, Frank Graves, Gunjan Bathla, and Lucas Bressan. 2010. *Potential Coal Plant Retirements under Emerging Environmental Regulations.* http://aceee.org/research-report/e102: Brattle Group.

Chittum, Anna, R. Neal Elliott and Nate Kaufman. 2009. *Industrial Energy Efficiency Programs: Identifying Today's Leaders and Tomorrow's Needs*, http://aceee.org/research-report/ie091. Washington, D.C.: American Council for an Energy-Efficient Economy.

[CRS] Congressional Research Service. 2010. *Displacing Coal with Generation from Existing Natural Gas-Fired Power Plants*. http://www.anga.us/media/41047/congressional%20research%20service%20-%20ng%20in%20power%20generation.pdf. Washington, D.C.: Congressional Research Service.

Dayton Daily News. 2011. "Duke Energy to Close Old Coal-Fired Plant by 2015," July 19.

[EIA] U.S. Energy Information Administration. 2010. *Form EIA-860, Annual Electric Generator Report.* http://www.eia.gov/cneaf/electricity/page/eia860.html. Washington, D.C.: U.S. Energy Information Administration.

Eldridge, Maggie, Steven Nadel, Amanda Korane, John A. "Skip" Laitner, Vanessa McKinney, Max Neubauer, and Jacob Talbot. 2009. *Potential for Energy Efficiency, Demand Response, and Onsite Solar Energy in Pennsylvania.* Research Report E093. http://aceee.org/research-report/e093. Washington, D.C.: American Council for an Energy-Efficient Economy.

Elliott, R.N. 2006. *America's Energy Straitjacket*, ACEEE Report E065, http://aceee.org/research-report/e065. Washington, D.C.: American Council for an Energy-Efficient Economy.

Friedrich, Katherine, Maggie Eldridge, Dan York, Patti Witte, and Marty Kushler. 2009. *Saving Energy Cost-Effectively: A National Review of the Cost of Energy Saved Through Utility-Sector Energy Efficiency Programs.* ACEEE Report U092. http://www.aceee.org/sites/default/files/publications/researchreports/U092.pdf. Washington, D.C.: American Council for an Energy-Efficient Economy.

Habacivch, Brian [Fellon McCord]. 2011. "Fortress America, A Resource Rich Island of Stability in a Sea of Turmoil." Presentation at *KAM 2011 Energy Conference*, http://www.kam.us.com/events/2011-energy-conference. Frankfort, KY: Kentucky Association of Manufacturers.

Harris, G. (TVA). 2011. Presentation at the Kentucky Association of Manufacturers 2011 Energy Conference, April 20, Louisville, KY.

Hayes, S., S. Nadel, M. Kushler, and D. York. 2011. *Carrots for Utilities: Providing Financial Returns for Utility Investments in Energy Efficiency.* ACEEE Report U111, http://aceee.org/research-report/u111. Washington, D.C., American Council for an Energy-Efficient Economy.

Hsu, Shi-Ling. 2006. *The Real Problem with New Source Review.* Environmental Law Review. http://faculty.law.ubc.ca/hsu/publications/ELRnsrfinal.pdf

[ICF] ICF International. 2010. *Coal-Fired Electric Generation Unit Retirement Analysis*, http://www.ingaa.org/File.aspx?id=10371. Washington, D.C.: Interstate Natural Gas Association of America.

_________. 2011. "ICF International Integrated Energy Outlook Forecasts Doubling of Natural Gas Generation by 2020," release July 11, http://www.icfi.com/news/2011/icf-integrated-energy-outlook-forecasts-doubling-natural-gas-generation-2020.

Kihm, S. 2009. "When Revenue Decoupling Will Work . . . And When It Won't." *Electricity Journal,* October, 22 (8): 19-28.

Laitner, Skip, Rachel Gold, Steven Nadel, Therese Langer, R. Neal Elliot, and Daniel Trombley. 2010. *The American Power Act and Enhanced Energy Efficiency Provisions: Impacts on the U.S. Economy.* Report E103. http://aceee.org/research-report/e103 Washington, D.C.: American Council for an Energy-Efficient Economy.

Laitner, Skip and Vanessa McKinney. 2008. *Positive Returns: State Energy Efficiency Analyses Can Inform U.S. Energy Policy Assessments.* Report E084. http://www.aceee.org/sites/default/files/publications/researchreports/e084.pdf

[Lazard] Levelized Cost of Energy Analysis - Version 3.0. 2009. http://www.narucmeetings.org/Presentations/2008%20EMP%20Levelized%20Cost%20of%20Energy%20-%20Master%20June%202008%20(2).pdf. New York, NY: Lazard Ltd.

[NERC] North American Electric Reliability Corporation. 2010. *Special Reliability Scenario Assessment: Resource Adequacy Impacts of Potential U.S. Environmental Regulation.* http://www.nerc.com/files/EPA_Scenario_Final.pdf. Princeton, N.J.: North American Electric Reliability Corporation.

_________. 2009. *2009 Long Term Reliability Assessment, 2009-2018.* Princeton, N.J.: North American Electric Reliability Corporation.

[MIT] MIT Energy Initiative. 2011. *The Future of Natural Gas: An Interdisciplinary MIT Study*, http://web.mit.edu/mitei/research/studies/naturalgas.html. Cambridge, Mass.: Massachusetts Institute of Technology.

Molina, Maggie, Max Neubauer, Michael Sciortino, Seth Nowak, Shruti Vaidyanathan, Nate Kaufman, and Anna Chittum. 2010. *The 2010 State Energy Efficiency Scorecard*, http://aceee.org/research-report/e107. Washington, D.C.: American Council for an Energy-Efficient Economy.

Mufson, S. 2011. "Utility AEP to Close some Coal Plants, Upgrade Others." *Washington Post*, June 9.

Nowak, Seth, Martin Kushler, Michael Sciortino, Dan York, and Patti Witte. 2011. *Energy Efficiency Resource Standards: State and Utility Strategies for Higher Energy Savings*, http://aceee.org/research-report/u113. Washington, D.C.: American Council for an Energy-Efficient Economy.

Petak, Kevin. 2011. "Impact of Natural Gas Supply on CHP Deployment," presented to the USCHPA *Spring CHP Forum*, May 5, http://www.uschpa.org/files/Conferences-Presentations/Spring%20CHP%20Forum%202011/Petak_Spring_CHP_Forum_05%2005%2011.pdf.

Sciortino, Michael, Seth Nowak, Patti Witte, Marty Kushler and Dan York. 2011. *Energy Efficiency at Work: State Performance Meeting Energy Efficiency Goals,* http://aceee.org/research-report/u112*.* Washington, D.C.: American Council for an Energy-Efficient Economy.

[SNL] SNL Financial LC. 2011. "ICF: Gas-Fired Generation to Increase; Coal Not Dead Yet." Release July 13. http://www.snl.com/InteractiveX/article.aspx?CDID=A-13024619-14636&KPLT=2.

Source Watch. 2011. "Existing Coal Plants." Web site access on 4/22/2011, http://www.sourcewatch.org/index.php?title=Existing_U.S._Coal_Plants.

Tierney, Susan. 2011. *Electric Reliability under New EPA Power Plant Regulations: A Field Guide.* http://www.wri.org/stories/2011/01/electric-reliability-under-new-epa-power-plant-regulations-field-guide. Washington, D.C.: World Resources Institute.

[TVA] Tennessee Valley Authority. 2011. *2011 Integrated Resource Plan*, http://www.tva.gov/environment/reports/irp/index.htm. Knoxville, Tenn.

Wald, M. 2009. "Big Utility to Close 11 Plants Using Coal." *New York Times*, December 1.