Deploying Low-Carbon Coal Technologies Series

THE STATE ROLE IN TECHNOLOGY INNOVATION

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1. Introduction

The development and deployment of low-carbon coal technologies[1] is critical to any plan to limit greenhouse gas emissions in the United States.[2] In 2011, coal-fired power generation contributed nearly 35% of national greenhouse gas (GHG) emissions.[3] While market forces and new environmental regulations are likely to limit near-term investments in new coal generation, energy projections indicate that coal will continue to supply a large portion of the nation's electricity in the coming decades.[4] There is little likelihood that the private sector will invest heavily in low-carbon coal technologies in the near future due to a combination of low natural gas prices and increasingly stringent environmental regulations.[5] The public sector has continued investing in research and development in recent years, and has made funds available for early demonstration projects.[6] But even with federal funding, advanced coal demonstration projects have faced barriers at the state level, highlighting the important, but often overlooked, role that state regulators will play in deploying low-carbon coal technologies.

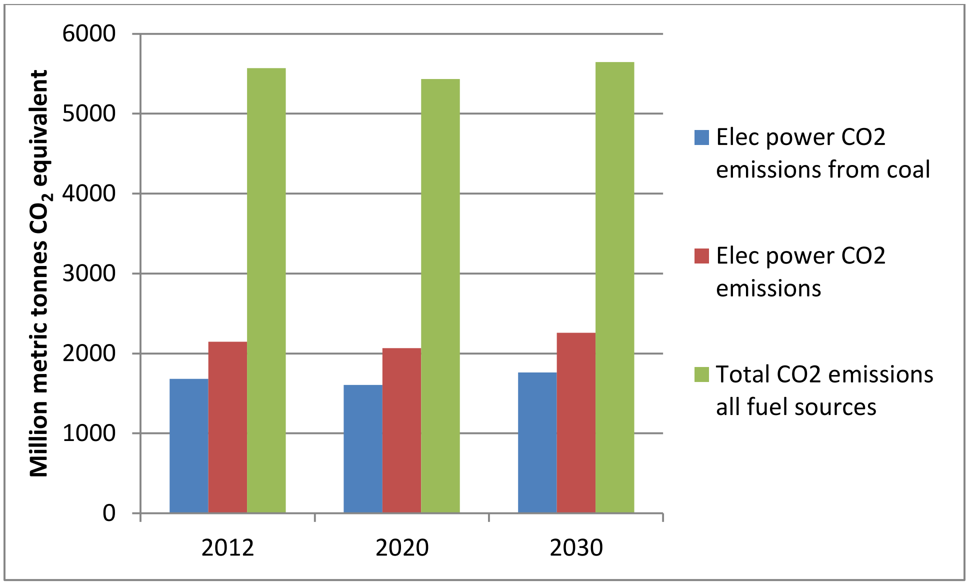

Figure 1. AEO 2012 reference case CO_2 emissions from electric power and all fuel sources.
Source: http://www.eia.gov/oiaf/aeo/tablebrowser/.

There are four general steps to bring innovative technologies into the marketplace: research, development, demonstration, and deployment.[7] Two decades of research and development have placed power-sector carbon capture and sequestration (CCS) technology between the demonstration and early deployment phases.[8] While the components of CCS technology—capture and compression of carbon dioxide (CO_2), transport of captured CO_2, and storage of CO_2 in geologic formations—are commercially ready,

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[1] Examples include but are not limited to carbon capture and sequestration at existing and new plants and advanced generation technologies such as integrated gasification combined cycle (IGCC) and oxy-combustion.
[2] *Report of the Interagency Task Force on Carbon Capture and Storage*, August 2010.
[3] U.S. Energy Information Administration, *Annual Energy Review 2011*, September 2012.
[4] U.S. Energy Information Administration, *Annual Energy Outlook 2012 With Projections to 2035*, June 2012.
[5] Experts have also noted that the regulatory structure for large-scale CO_2 transportation and sequestration is unsettled and could become an impediment to wide adoption of advanced coal with carbon capture and sequestration. See *Carbon Capture and Sequestration: Framing the Issues for Regulation* by the CCSReg project.
[6] Folger, Peter, "Carbon Capture and Sequestration: Research, Development, and Demonstration at the U.S. Department of Energy," *Congressional Research Service* R42496, April 23, 2012.
[7] Newell, Richard G. "Literature Review of Recent Trends and Future Prospects for Innovation in Climate Change Mitigation," *OECD Environment Working Papers, No. 9,* OECD Publishing, 2009.
[8] *Report of the Interagency Task Force on Carbon Capture and Storage*, August 2010.

widespread deployment requires that these technologies be integrated with coal-fired power generation and demonstrated at scale.[9] Advanced coal generation technologies that have the potential to reduce the cost of capturing carbon from new or retrofitted coal-fired power plants[10] similarly require demonstration to foster learning.[11,12] Currently, there are few low-carbon coal demonstration projects under way in the United States, and additional projects are necessary to commercialize the technologies.[13]

Demonstrating and deploying low-carbon coal technologies at scale poses a number of challenges, including unique regulatory hurdles in states with traditionally regulated electricity markets. These projects require large capital expenditures and carry a high degree of technology risk. While low-carbon coal projects may have broad societal benefits, placing the cost burden on local ratepayers can render projects untenable from the perspective of the regulators responsible for ensuring that electricity rates are just and reasonable.[14] It may be even more untenable when ratepayers are asked to pay higher electricity costs to fund a demonstration project located in another state. To address these challenges, this paper provides (1) an overview of the federal and state policies affecting deployment of low-carbon coal technologies, (2) a case study of two proposed Appalachian Power Company (APCo) demonstration projects that illustrate the particular challenges in traditionally regulated states, and (3) options for both traditionally regulated and restructured states to address state-level challenges regarding technology deployment.

2. Federal GHG Regulation and R&D Funding

In March 2012, the U.S. Environmental Protection Agency (EPA) proposed GHG New Source Performance Standards for coal-fired power plants and natural gas combined cycle turbines. If adopted, the new rule will effectively require new coal-fired power plants to reduce greenhouse gas emissions through carbon capture and sequestration (CCS).[15] Even if the EPA does not finalize the rule as written, coal-fired power plants risk high compliance costs if the United States adopts a policy to reduce greenhouse gas emissions from the electricity sector.

Though coal-fired power plants pose significant environmental challenges, coal is an abundant domestic fuel source with relatively low and stable prices, it contributes to generation diversity, and the industry is a key employer in many coal-producing states. For these reasons and others, coal-dependent utilities,[16] coal states,[17] and coal state utility commissioners[18] have repeatedly called for investment in advanced coal

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[9] *Report of the Interagency Task Force on Carbon Capture and Storage*, August 2010.

[10] Coal gasification and oxy-combustion plants produce exhaust streams with high CO_2 concentrations and do not require post-combustion carbon capture.

[11] Rubin, Edward S. "The Government Role in Fostering Technology Innovation for Climate Change Mitigation," Presentation of the Zurich Distinguished Visitor Lecture Bren School of Environmental Science & Management, University of California Santa Barbara, February 22, 2012.

[12] See, Department of Energy, *Clean Coal Power Initiative: Advanced Energy Systems*, Accessed November 16, 2012 at http://fossil.energy.gov/programs/powersystems/index.html.

[13] One coal gasification plant is under construction in Mississippi and will capture CO_2 for use in enhanced oil recovery. Another coal gasification plant is nearly complete in Indiana but has no near-term plans for carbon capture. Additional CCS projects are under development but have yet to break ground in Texas, Illinois (FutureGen), and California. In this paper, the term *demonstration project* includes commercial-scale power plants that capture CO_2 or produce concentrated CO_2 exhaust streams.

[14] Costello, Ken, "New Technologies: Challenges for State Utility Regulators and What They Should Ask," *National Regulatory Research Institute*, January 2012.

[15] Proposed Rule: Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, F. R. Vol. 77 No. 72, April 13, 2012.

[16] See, e.g. Coal Utilization Research Council & Electric Power Research Institute, "The CURC-EPRI Coal Technology Roadmap," August 2012 Update.

[17] See, e.g. Warchol, Glen, "Gov's call for clean coal funding backed by his Western peers," *The Salt Lake Tribune*, June 11, 2007 at: http://www.sltrib.com/news/ci_6111919; "Ritter, fellow governors ask Obama to support 'clean coal technologies,'" *Denver Business Journal*, February 22, 2009 at: http://www.bizjournals.com/denver/stories/2009/02/16/daily69.html?page=all; "Governors: Coal must be part of energy debate," *ABC News*, at: http://abcnews.go.com/Business/story?id=4335172&page=1 - .UFDPyIXi-mE.

technologies. Yet, if these groups are to achieve broad deployment of advanced coal technologies, they will need innovative strategies for sharing the costs, risks, and benefits of demonstration projects.

To date, there has been some focus on the challenge of bringing advanced coal technologies to market, including the federal government's role in research, demonstration, and deployment (RD&D). The Department of Energy has pursued CCS research and development since 1997, and Congress has appropriated nearly $6 billion for CCS RD&D since 2008.[19,20] Despite these efforts, in current and foreseeable market conditions, advanced coal technology is not cost-effective on an individual project basis without public funding or policy support.

Federal support for advanced coal demonstration projects effectively spreads a portion of the cost across all taxpayers, with the rationale that demonstration projects (1) create benefits for the electricity industry and the U.S. economy, (2) have inherent capital and operating cost risk and (3) are generally not a profitable investment for an individual project developer. The Coal Utilization Research Council and Electric Power Research Institute recently released their "Coal Technology Roadmap," which identifies a pathway to widely deploy advanced coal technology that would rely on $6.2 billion in public funding to build demonstration projects through 2025 and $3.5 billion to build additional projects between 2026 and 2035.[21,22] More recently, Senators Conrad, Enzi, and Rockefeller introduced legislation that would increase access to an existing tax credit for projects that capture carbon for use in enhanced oil recovery.[23]

3. The State Role in Energy Technology Deployment

The role of states in technology demonstration and deployment has received much less attention than that of the federal government, but is nonetheless important to developing advanced coal technologies. State electric utility regulation falls in two general categories—restructured states[24] and traditionally regulated states—presenting different challenges to deploying low-carbon coal technologies.

Low-carbon coal projects in restructured states

In restructured states, lawmakers have replaced traditional regulation of vertically integrated electric utilities with wholesale markets for electricity generation in which electricity generators sell power competitively. In these states, the barriers to low-carbon coal demonstration projects are primarily economic. While plant operators generally do not need approval from a state utility commission to deploy low-carbon coal technologies, the operators are also left without the certainty of cost recovery through rates that traditionally regulated states can provide.

As demonstrated in table 1, the U.S. Energy Information Administration projects that advanced coal demonstration projects with CCS will be the most expensive generation option for plants entering service in 2017. Investors planning two low-carbon coal demonstration projects in Texas and California hope to address the higher costs of generating electricity by combining federal funding with additional revenue

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[18] See, e.g. National Association of Regulatory Utility Commissioners Subcommittee on Clean Coal and Carbon Sequestration, "Resolutions" Adopted June 20, 2011 supporting state and federal policies to support carbon capture and enhanced oil recovery at: http://www.naruc.org/committees.cfm?c=49.

[19] This total includes funding from the American Recovery and Reinvestment Act.

[20] Folger, Peter, "Carbon Capture and Sequestration: Research, Development, and Demonstration at the U.S. Department of Energy," *Congressional Research Service* R42496, April 23, 2012.

[21] Plus funds for research and development.

[22] Coal Utilization Research Council & Electric Power Research Institute, "The CURC-EPRI Coal Technology Roadmap," August 2012 Update.

[23] S.3581 A bill to amend the Internal Revenue Code of 1986 to modify the credit for carbon dioxide sequestration. 112th Congress.

[24] Fifteen states and the District of Columbia have restructured electricity markets. (Connecticut, Delaware, Illinois, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Oregon, Pennsylvania, Rhode Island, and Texas). EIA Electricity Restructuring by State: http://www.eia.gov/cneaf/electricity/page/restructuring/restructure_elect.html. California has a competitive wholesale market but rates are set by the state utilities commission (http://www.cpuc.ca.gov/puc/).

streams from commercial byproducts. For example, the Hydrogen Energy California (HECA) facility plans to convert coal and petroleum coke to hydrogen energy and use that hydrogen both to generate electricity and to produce low-carbon hydrogen fertilizers.[25] HECA also plans to capture and sell carbon dioxide for use in enhanced oil recovery.[26] The Texas Clean Energy Project similarly plans to construct an integrated gasification combined cycle (IGCC) coal plant that would produce urea for the fertilizer market and capture and sell carbon dioxide for enhanced oil recovery.[27] Because they are located in states with competitive markets for electricity generation, these private investors bear the risk (mitigated in part by federal grants) of construction cost overruns, technological complications, and other market factors that could undermine project finances. Current conditions make investment in new generation in restructured markets challenging. Due in part to low natural gas prices, many restructured markets are struggling to attract investment in low-cost natural gas generation.[28]

Table 1. Estimated levelized cost of new generation resources, 2017.

U.S. average levelized costs (2010 $/megawatt hour) for plants entering service in 2017						
Plant type	**Capacity factor (%)**	**Levelized capital cost**	**Fixed O&M**	**Variable O&M (including fuel)**	**Transmission investment**	**Total system levelized cost**
Dispatchable technologies						
Conventional coal	85	64.9	4.0	27.5	1.2	97.7
Advanced coal	85	74.1	6.6	29.1	1.2	110.9
Advanced coal with CCS	*85*	*91.8*	*9.3*	*36.4*	*1.2*	*138.8*
Conventional natural gas-fired combined cycle	87	17.2	1.9	45.8	1.2	66.1
Advanced combustion turbine	30	31.0	2.6	64.7	3.6	101.8
Advanced nuclear	90	87.5	11.3	11.6	1.1	111.4
Geothermal	91	75.1	11.9	9.6	1.5	98.2
Biomass	83	56.0	13.8	44.3	1.3	115.4

Source: U.S. EIA, Levelized Cost of New Generation Resources in the Annual Energy Outlook 2012, http://www.eia.gov/forecasts/aeo/electricity_generation.cfm.

Low-carbon coal projects in traditionally regulated states

While low-carbon coal technologies face economic hurdles under both regulatory structures, projects in traditionally regulated states face the additional challenge of approval through a regulatory process that aims to protect consumers from imprudent utility investments and undue risk. In these states, public utility commissions review investments and set electricity rates,[29] and thus the viability of an advanced demonstration project depends on commission approval.

Approval of demonstration project costs could provide the certainty needed for demonstration projects to move forward, but commissions are generally reluctant to approve ratepayer funding of large demonstration projects, even if commission members believe that demonstration projects are necessary. The "regulatory compact" allows monopoly utility providers to recover all "used and useful/prudent"

[25] Hydrogen Energy California, The Project. Available at http://hydrogenenergycalifornia.com/the-project (Last visited December 3, 2012).
[26] Ibid.
[27] Texas Clean Energy Project, Available at http://www.texascleanenergyproject.com/, (Last visited December 3, 2012).
[28] For example, the Electric Reliability Council of Texas faces insufficient new generation to meet reserve margins because expected returns are too low (http://www.brattle.com/_documents/UploadLibrary/Upload1047.pdf), and Maryland has ordered in-state utilities to construct new generation because "a PJM Interconnection pricing model has failed to attract enough new generation" (http://www.platts.com/RSSFeedDetailedNews/RSSFeed/ElectricPower/6537766).
[29] In restructured states, markets determine and control generation costs for ratepayers.

capital investments, a reasonable rate of return, and operating costs from ratepayers within a utility's service area.[30] To evaluate potential investments and the inclusion of costs incurred in utility rates, utility commissions consider whether the investment is prudent—generally interpreted as least-cost—and whether it provides a *direct benefit* to ratepayers.[31] Demonstration projects carry high capital and operating costs, substantial risks associated with new technology, and uncertain and diffuse benefits (learning).

Facing high costs and climate policy uncertainty, public utility commissions in traditionally regulated states can and have disallowed ratepayer funding of advanced coal projects despite federal cost sharing, leading utilities to abandon demonstration projects. The current environment of low natural gas prices and climate policy uncertainty is also unlikely to attract private investors to pursue low-carbon coal projects in restructured states. In the near term, states, utilities, and utility regulators who are committed to developing and deploying advanced coal technologies will need innovative strategies to overcome these obstacles.

4. The APCo Case Study

Two examples illustrate the challenges of advanced coal demonstration projects in traditionally regulated states. In both cases APCo—a subsidiary of American Electric Power that serves customers in West Virginia and Virginia—sought commission approval of advanced coal projects with federal support. While both commissions commended the company's effort to develop advanced coal technologies, neither project moved forward due, at least in part, to state regulatory treatment of the proposals.

In March 2008, APCo sought regulatory approval to construct a 629 MW IGCC coal-fired power plant in Mason County, West Virginia. The $2.23 billion project was estimated to cost 20%–30% more than a pulverized coal unit.[32] The company planned to pursue federal tax credits and additional state incentives to offset the cost.[33] The Public Service Commission of West Virginia approved the project, reasoning that the capacity was necessary, the technology was adequately demonstrated, and the project fulfilled the commission's statutory obligation to "encourage the well-planned development with utility resources in a manner . . . consistent with the productive use of the state's energy resources, such as coal."[34] The Virginia commission found, on the contrary, the technology was not commercially proven and the cost estimate was not credible, creating an "extraordinary risk" that the commission could not allow ratepayers to assume.[35]

APCo later sought regulatory approval of costs incurred during the initial phase of a CCS demonstration project at the existing Mountaineer coal-fired power plant in West Virginia. The Virginia State Corporation Commission again articulated the difficulty of allowing ratepayers to assume the cost and risk of demonstration projects:

> It is reasonable for AEP to evaluate and explore options regarding potential federal legislation or regulation regarding GHG emissions. We do not find, however, that it was reasonable for APCo to incur the Mountaineer CCS project costs and then seek recovery from Virginia ratepayers. . . .

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[30] See, e.g. Raymond Jackson, *Regulation and Electric Utility Rate Levels*, 45 LAND ECONOMICS, at 373 (1969).
[31] See, e.g. William Gormley, THE POLITICS OF PUBLIC UTILITY REGULATION, (University of Pittsburg Press 1983)
[32] Public Service Commission of West Virginia, "Commission Order on the Application for a Certificate of Public Convenience and Necessity for a 629 MW Integrated Gasification Combined Cycle Electric Generating Station in Mason County," March 6, 2008. Case No. 06-0033-E-CN.
[33] Public Service Commission of West Virginia, "Commission Order on the Application for a Certificate of Public Convenience and Necessity for a 629 MW Integrated Gasification Combined Cycle Electric Generating Station in Mason County," March 6, 2008. Case No. 06-0033-E-CN.
[34] W. Va. Code § 24-1-1
[35] Commonwealth of Virginia State Corporation Commission, "Final Order: Application of Appalachian Power Company for a rate adjustment pursuant to § 56-585.1 A 6 of the Code of Virginia," Case No. PUE-2007-00068 April 14, 2008.

although AEP asserts that this demonstration project will benefit customers of all of AEP's operating companies and of all utilities in the United States, APCo's ratepayers (not shareholders) are being asked to pay for all of the costs incurred by this project.[36]

In this case the West Virginia Public Service Commission also articulated a broader responsibility for demonstration project costs, approving only a portion[37] of APCo's costs on the basis that ratepayers of other AEP companies were also benefiting from the CCS demonstration project and should therefore share the expense.[38] APCo later canceled phase two of the project, a commercial-scale demonstration of carbon capture, even though the Department of Energy had committed to fund 50% of the project ($334 million), citing the difficulty of recovering project costs as a regulated utility, among other challenges.[39]

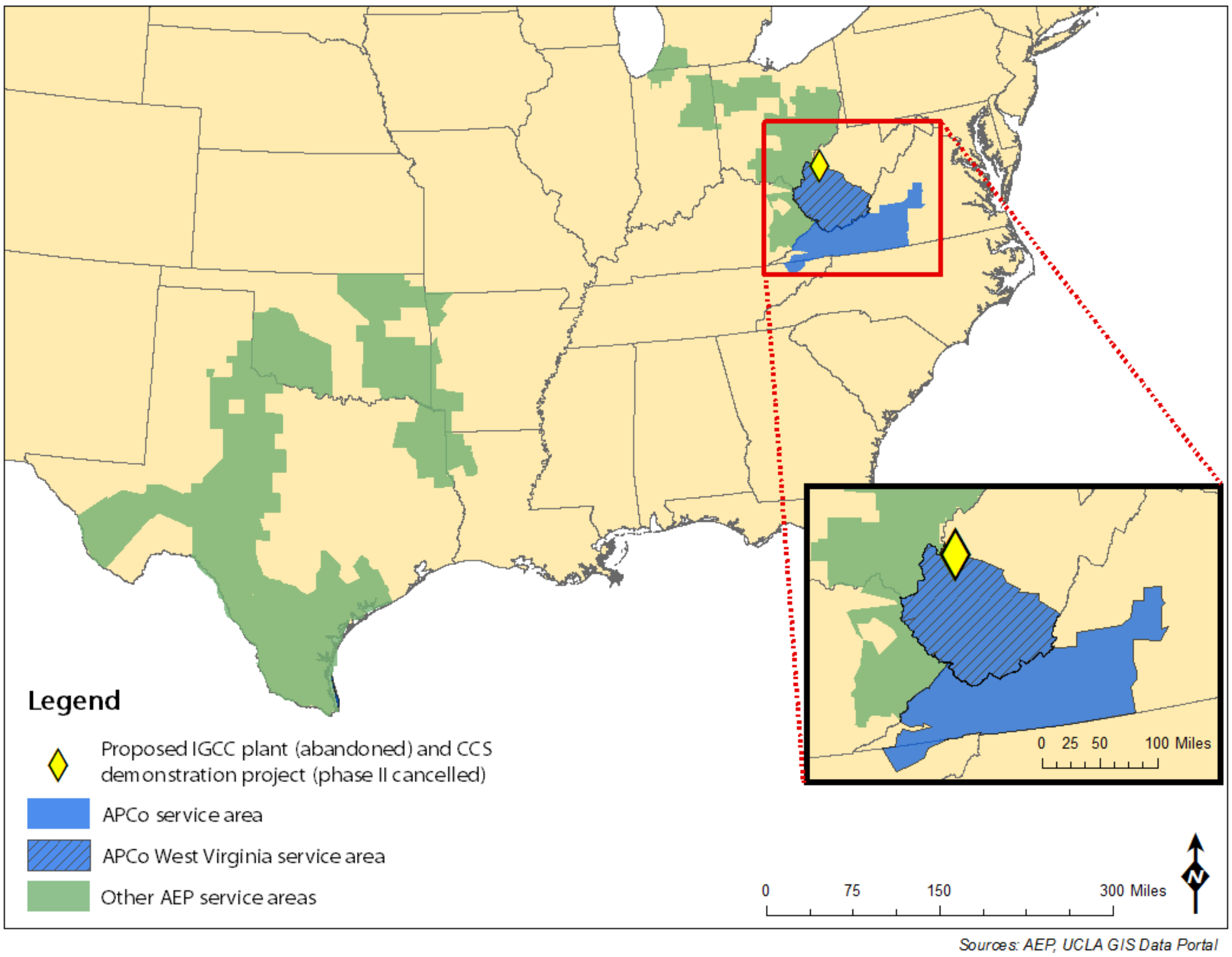

Figure 2. Service territories of AEP and APCo, an AEP subsidiary.

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[36] Commonwealth of Virginia State Corporation Commission, "Final Order: Application of Appalachian Power Company for a statutory review of rates, terms and conditions for the provision of generation, distribution and transmission services pursuant to § 56-585.1 A of the Code of Virginia," Case No. PUE-2009-0030. July 14, 2010 (emphasis added).

[37] 32%, Appalachian Power Company's share of AEP East coincidental peak load.

[38] Public Service Commission of West Virginia, "Commission Order on the Application for a Rate Increase," March 30, 2011. Case No. 10-0699-E-42T.

[39] American Electric Power, Environmental News Releases: "AEP Places Carbon Capture Commercialization On Hold, Citing Uncertain Status Of Climate Policy, Weak Economy," (Citing Chairman and CEO's statement that "as a regulated utility it is impossible to gain regulatory approval to recover our share of the costs…without federal requirements…already in place.") Accessed October 1, 2012 at: http://www.aep.com/environmental/news/?id=1704.

These two examples highlight several challenges of advanced coal demonstration projects in traditionally regulated states:

- **High, uncertain costs:** Demonstration projects tend to be expensive compared to mature generation projects, which have benefited from technological learning and economies of scale. In addition, it is inherently difficult to estimate construction and operating costs of projects that rely on new technologies. As a result, it is difficult for public utility commissions—charged with ensuring that electricity rates are just and reasonable—to allow ratepayers of a particular utility to accept the cost and risk of demonstration projects.

- **Coal-specific costs:** Allowing ratepayers to fund coal demonstration projects can be especially challenging because these projects are expensive relative to other demonstration projects in the electricity sector. The nation's largest smart grid demonstration project[40] will cost $178 million, shared between the U.S. Department of Energy (DOE) (50%) and other project participants, including eleven utilities, Bonneville Power Administration, and private investors.[41] One utility's share of the cost—for example the $2.1 million that Northwest Energy will invest—is a small fraction of the costs of advanced coal demonstration projects described above.[42] Even the total project cost of $178 million is substantially lower than APCo's $334 million share of the CCS demonstration project proposed at the Mountaineer coal-fired power plant.

- **Uncertain economic benefits:** Advanced coal projects that employ or facilitate CCS have the potential to provide direct benefits to ratepayers through reduced compliance costs if and when the utility faces a policy to reduce greenhouse gas emissions. But without a policy in place, the timing and magnitude of those benefits are unknown, making it difficult for state utility regulators to weigh the costs and benefits of proposed projects.

- **Challenges with interstate cooperation:** Utility service areas frequently cross state boundaries, complicating the task of securing regulatory approval for new investments. The differential treatment of advanced coal projects in West Virginia and Virginia illustrates the added risk for projects that require the approval of multiple state public utility commissions. Further complicating the challenge of interstate cooperation, certain economic benefits of demonstration projects—jobs, economic development, potentially creating demand for coal—accrue primarily to the state where the plant is located.

- **Diffuse societal benefits:** In addition to any direct benefits to ratepayers from reduced future compliance costs, demonstration projects provide learning benefits to the U.S. economy, the electricity sector, and all electricity consumers.[43] However, it is difficult to ask any one utility's ratepayers, or subset of ratepayers, to bear the cost and risk of a project with widespread benefits. The diffuse benefits from technology development may be larger than project benefits realized by ratepayers, especially for small-scale demonstration projects with minor emissions reductions, further disincentivizing commission approval of ratepayer support for these types of projects.

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[40] Imhoff, Carl "Largest U.S. Smart Grid Demo is Set to Roll," *IEEE: Smart Grid*, June 2012.
[41] Pacific Northwest Smart Grid Demonstration Project, "About the Project," Accessed October 1, 2012 at: http://www.pnwsmartgrid.org/about.asp.
[42] NorthWestern Energy, "Smart Grid Demonstration Project," Accessed October 1, 2012 at: http://www.northwesternenergy.com/display.aspx?Page=Smart_Grid&Item=429.
[43] Yeh, Sonia., Rubin, Edward S., "A review of uncertainties in technology experience curves," Energy Economics 34 (2012) 762-771.

With the exception of policies promoting renewable energy (RE) and energy efficiency (EE),[44] utility regulation in the U.S. is generally not designed to extend costs beyond a utility's service area. As a result, approving demonstration projects requires commissions to make the difficult decision that ratepayers within a particular service area should bear the cost and risk of a project with widespread benefits. Statutory directives for utility regulators to encourage the continued use of coal facilitated commission approval of advanced coal projects in Indiana and West Virginia.[45] Similarly, Mississippi commissioners approved an IGCC project to balance the utility's heavy reliance on natural gas.[46] However, construction cost overruns in Indiana and Mississippi, low natural gas prices, climate policy uncertainty, and fewer federal dollars suggest these decisions will become even more difficult without innovative strategies that protect ratepayers and provide for an equitable distribution of costs and benefits.

5. Options for Cost Sharing among States

State governments and utility commissions can and do require ratepayers to pay for higher-cost generation technologies to achieve state policy goals, hedge risk, and advance technology. For example, in the APCo IGCC case described above, the West Virginia Public Service Commission approved APCo's proposal, acknowledging that it would cost 20%–30% more than a pulverized coal plant.[47] However, because of the large cost of advanced coal demonstration projects, the cost burden for ratepayers can be unacceptably high, even with federal cost sharing. The key challenge for states is further reducing the cost of the technologies to acceptable levels while demonstrating commensurate benefits for ratepayers.

By reducing the burden on individual ratepayers, cost (and benefit) sharing can alleviate the barriers to approval and cost recovery for demonstration projects. There are multiple options for sharing costs and benefits, including strategies that could be adopted by utilities, a single state, or groups of states. Many of the opportunities for states to create funding mechanisms or markets for advanced coal technologies can also apply in restructured states, where state funding (or guaranteed markets) would reduce investor costs and allow wholesale electricity from advanced coal projects to compete.

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[44] A major difference between advanced coal and RE/EE is the size of individual projects and their capital costs. Policies that spread the cost of EE/RE projects across all ratepayers tend to have relatively small impacts on rates. However, the theory behind widely sharing the cost of RE/EE projects, which create external benefits such as improved air quality and technological advancement, is similar to the rationale for sharing the costs of advanced coal projects. The goal of the policy tools proposed here is to similarly share costs so that advanced coal projects have relatively small rate impacts.

[45] Indiana Utility Regulatory Commission, "Final Order: Joint Petition and Application of Duke Energy Indiana…" Cause No. 43114, Issued November 20, 2007.; Public Service Commission of West Virginia, "Commission Order on the Application for a Certificate of Public Convenience and Necessity for a 629 MW Integrated Gasification Combined Cycle Electric Generating Station in Mason County," March 6, 2008. Case No. 06-0033-E-CN.

[46] The Public Service Company of the State of Mississippi, "Order In Re: Petition of Mississippi Power Company for a certificate of public convenience and necessity authorizing the acquisition, construction, and operation of an electric generating plant, associated transmission facilities, associated gas pipeline facilities, associated rights-of-way, and related facilities in Kemper, Lauderdale, Clarke, and Jasper Counties, Mississippi," Docket No. 2009-UA-14 Issued April 29, 2010.

[47] Other examples include state renewable portfolio standards which require ratepayers to pay additional costs to increase the market for renewable generation. In Illinois, the state has passed a portfolio standard for clean coal, ensuring a market for higher-cost clean coal generation. A Policy Strategy for Carbon Capture and Storage, IEA, Jan 2012.

Joint ownership

It is not uncommon for utilities to share ownership of large generation facilities through bilateral or multilateral agreements. Recent examples include nuclear units under construction in South Carolina[48] and Georgia.[49] Mississippi Power recently announced a sale of 15% of its 582 MW lignite-fired IGCC facility under construction in Kemper County to South Mississippi Electric Power Association (SMEPA), which provides electricity to 11 cooperatives in the state.[50] These ownership arrangements help utilities attain economies of scale, spread risk, and reduce the impact on individual ratepayers. A key benefit of sharing ownership, as opposed to establishing power purchase agreements for wholesale electricity, is that these arrangements can divide the risk among utilities and among a larger pool of ratepayers, reducing the risk borne by any single utility and its customers. Sharing ownership more widely and spreading costs across all or most of the ratepayers in an individual state or group of states would significantly reduce advanced coal projects rate impacts on a dollar-per-kilowatt-hour ($/kWh) basis, and would further spread the risk of project cost escalation. For example, a $1 billion dollar demonstration project with $100 million in annual incremental operating costs paid for by a utility serving a population of 500,000[51] would increase electricity prices by almost 3 cents/kWh,[52] but sharing these costs across a state with a population of 4 million[53] would raise electricity prices approximately 0.35 cents/kWh. Sharing costs across the top 5 coal states would raise price less than 0.1 cents per kWh.

Table 2. Rate impacts of $1 billion advanced coal demonstration project with $100 million incremental operating costs.

Cost sharing entity	$ per kWh	Increase in 2011 West Virginia residential rate
Individual utility serving 500,000 residents*	$0.027	29%
Individual state with 4 million residents†	$0.003	4%
Top 5 coal states by % generation	$0.001	1%
Top 10 coal states by % generation	$0.0004	0.4%

*Based on per capita electricity use in West Virginia in 2010.
†Assumes all generation consumed locally; no exports.
Data from EIA Electric Power Monthly 2/2012.

Utilities are free to form and propose joint demonstration projects without state legislative action. Utility commissions cannot require utilities to submit joint proposals for demonstration projects that share costs across a large customer base, but they can express support for these actions during regulatory proceedings or through public comments and approve projects that meet their criteria for prudency.[54] Utility commissioners can also use national (and regional) organizations, such as the National Association of

[48] South Carolina Electric & Gas Company (SCE&G) is jointly developing two new nuclear reactors in Jenkinsville, South Carolina. SCE&G will own 55% of the two units, and Santee Cooper, an electric cooperative supply company, will own 45%. In its order granting a Certificate of Public Convenience and Necessity (CPCN) for the units, the South Carolina Public Service commission notes, "the construction of two units allows SCE&G to partner with Santee Cooper, spreading risk in the project, and providing a benefit to the state's electric cooperatives and customers."

[49] Georgia Power is constructing two new nuclear units at Plant Vogtle. The company will own 45.7% of the facility. Oglethorpe Power Corporation (an electric supply cooperative), MEAG Power (a consortium of public power systems), and Dalton Utilities (a municipal utility) will own 30%, 22.7%, and 1.6%, respectively.

[50] See "SME to buy gas-fired Batesville, Kemper IGCC power plant assets," *Penn Energy*, August 24, 2012. Available at: http://www.pennenergy.com/index/power/display/9992743905/articles/pennenergy/power/gas/2012/august/sme-to_buy_gas-fired.html.

[51] Example utility serves industrial, commercial, and residential customers. Based on per capita electricity sales to all customer classes in West Virginia in 2011. $1 billion capital costs are incremental capital costs relative to alternative generation options.

[52] Assuming a pre-tax cost of capital of 12.7% and 30-year amortization.

[53] Same assumptions as footnotes 47 and 48 for larger population.

[54] For example, the Public Service Company of Mississippi outlined specific conditions under which it would consider Mississippi Power Company's proposed IGCC project to be in the public interest in an order denying a CPCN under the company's proposed terms. Commission Order issued April 29, 2010, Docket No. 2009-UA-14.

Regulated Utility Commissioners (NARUC), to express support for utility cooperation on demonstration projects.[55]

In addition to reducing the impact of demonstration projects on utility rates, shared ownership of advanced generation also mitigates (but does not eliminate) the fairness concerns that commissions have expressed when asked to require one utility's ratepayers to bear the cost of a project with widespread benefits.

Sharing costs across an entire state or multiple states would more directly address this concern, but it would likely mean some of the ratepayers paying for the demonstration project would never "use" the generation because it is outside of the local market or balancing area. This would represent a significant change from traditional financing for nonrenewable generation. Cost sharing beyond a traditional service area would likely require state legislation to adjust state utility regulation rules for demonstration projects. In addition, legislation encouraging or requiring all utilities within a state to participate to avoid free riders may be necessary. Encouraging cooperative and municipal utility participation would further spread costs and risk. New mechanisms to share project ownership and revenues may also be required. For example, costs and revenues could also be shared through distribution companies.[56] Sharing costs broadly across multiple states (as opposed to across ratepayers that "use" the generation) would require participating states to independently adopt similar legislation. In the case of CCS demonstration projects at existing plants, which do not create additional generation that ratepayers "use," multiple utilities could form agreements to share project ownership and benefits.

Sharing benefits of advanced coal projects

Along with furthering the development of advanced coal technology, advanced coal projects create benefits by reducing regulatory and fuel-price risk for utilities and ratepayers. Advanced coal generation technologies capture or facilitate capturing CO_2 emissions and generally have conventional pollutant emissions that are significantly lower than traditional pulverized coal plants. In the future, these lower emissions rates and potentially sequestered CO_2 could create benefits for project owners if federal emissions standards are tightened, or if the cost of emissions increases under a cap-and-trade or taxing mechanism. If ratepayers are paying more for advanced coal technology and taking on additional project risk, ensuring that ratepayers directly benefit from potential upsides should encourage willingness to pay and approval of projects.

In traditionally regulated electricity markets, utilities typically pass the costs (operating and capital) of environmental compliance to ratepayers. Lower emissions should result in low compliance costs for ratepayers, but ratepayers may not capture all of these benefits depending on rate structures and the frequency of rate cases. For example, if ratepayers fund an advanced coal plant that sequesters CO_2 and the corresponding emissions reduction can later be sold, ratepayers who paid extra for the project might not see lower rates because traditional regulation may not include the sequestration profits in a future rate case. States should be able to create rate-setting mechanisms to ensure that ratepayers benefit from potential sales of sequestered or reduced emissions in the future.

Technology development and operational knowledge gains are also potential benefits of advanced generation and demonstration projects. As part of a recent settlement agreement between the Public Service Company of Mississippi and Mississippi Power Company, Mississippi Power customers will receive 10% of any royalty revenues from the licensing of the Kemper plant gasification technology.[57]

[55] NARUC regularly passes resolutions supporting various actions or explaining commissioner perspectives. http://www.naruc.org/Policy/resolutions.cfm.

[56] This would enable cost (and benefits) sharing in restructures states.

[57] Settlement Agreement between Mississippi Power Company and the Mississippi Public Service Commission, January 24, 2013

Mechanisms like this ensure that ratepayers realize some of the technological benefits of advanced coal projects.

State demonstration project funding

Sharing ownership and benefits of advanced coal demonstration projects reduces cost and risk impacts for ratepayers but likely will be insufficient on its own to encourage utility investment in advanced coal projects. Funding and/or policy support will also be required. All advanced coal projects currently planned or under construction in the U.S. receive direct federal funding and/or tax credits. For example, Mississippi Power's Kemper IGCC plant now under construction, which will capture carbon for use in enhanced oil recovery, received $270 million in direct federal funding[58] and $133 million in federal investment tax credits.[59] DOE has also granted financial support to the FutureGen,[60] HECA[61] and Texas Clean Energy Project.[62] Individual states, or a group of states, can promote demonstration projects by creating pooled demonstration project funds that facilitate investment in advanced coal, keeping in mind that multistate projects are likely to face additional challenges of distributing costs and benefits among the states, given that economic development and job growth benefits may be localized.

States can create funding for demonstration projects through tax incentives,[63] system benefits charges, wire charges, or fees on each megawatt hour (MWh) of coal or fossil generation. These types of funding mechanisms would require systems to manage the use of these funds and oversee projects.[64] For individual states, utility commissions may be able to take on this role. Groups of states would have to contract with a nongovernmental organization to avoid compact clause concerns.[65] Partial state ownership of projects would create opportunities to use tax-free bond financing, but states generally do not have expertise developing and managing power plants.

Another method for states to fund advanced coal projects is through fees on GHG emissions from fossil fuel power plants. A wires fee based on the GHG emissions intensity of each MWh of generation across an individual state or multiple states would spread the cost of advanced coal and provide a steady stream of funding. Again, this would require a mechanism to manage these funds. Another alternative proposed by Patino-Echeverri, Burtraw, and Palmer would create a flexible GHG emissions performance standard with alternative compliance payments into an escrow fund that the company can later use to pay for advanced coal projects.[66] This system creates economic incentives to construct new generation that meets

[58] U.S. Department of Energy, Clean Coal Power Initiative Round 2 Selections, Accessed October 1, 2012 at: http://www.fossil.energy.gov/programs/powersystems/cleancoal/ccpi/CCPI_Round_2_Selections.html.
[59] The Public Service Company of the State of Mississippi, "Order In Re: Petition of Mississippi Power Company for a certificate of public convenience and necessity authorizing the acquisition, construction, and operation of an electric generating plant, associated transmission facilities, associated gas pipeline facilities, associated rights-of-way, and related facilities in Kemper, Lauderdale, Clarke, and Jasper Counties, Mississippi," Docket No. 2009-UA -14 Issued April 29, 2010.
[60] U.S. Department of Energy, FutureGen 2.0, Accessed October 1, 2012 at: http://www.fossil.energy.gov/programs/powersystems/futuregen/index.html.
[61] Hydrogen Energy California, The Project. Available at http://hydrogenenergycalifornia.com/the-project
[62] Texas Clean Energy Project, "DOE's Charles McConnell on TCEP," (Noting that DOE granted TCEP $450 million in Clean Coal Power Initiative funding) Accessed October 1, 2012 at: http://www.texascleanenergyproject.com/.
[63] Carbon Dioxide Enhanced Oil Recovery: A Critical Domestic Energy, Economic, and Environmental Opportunity, National Enhanced Oil Recovery Initiative, Center for Climate and Energy Solutions, Great Plains Institute, February 2012.
[64] For example, House Resolution 6258 in the 110th Congress proposed a Carbon Storage Research Corporation within the Electric Power Research Institute governed by 12 board members representing different sectors of the electricity industry to allocate funding from a national wires charge to finance CCS research and demonstration projects. http://thomas.loc.gov/cgi-bin/query/z?c110:H.R.6258.IH:.
[65] Article I, Section 10, Clause 3, of the U.S. Constitution states that, "No State shall, without the consent of Congress . . . enter into any Agreement or Compact with another State." The northeast states' regional greenhouse gas initiative, for example, avoids violating the compact clause by relying on each state to independently adopt similar legislation and contract with a common nongovernmental organization to administer the program.
[66] Patino-Echeverri, Burtraw and Palmer. Flexible Mandates For Investment in New Technology, *Resources For the Future*, RFF DP 12-14, March 2012.

the performance standard without prolonging the life of existing plants indefinitely. Ideally the performance standard would apply to all existing and new construction fossil generation to spread out costs. Escrow funds could also be pooled across multiple companies to create a larger source of funds with the previously mentioned challenge of how to manage them.

Guaranteed market for advanced coal generation

Another state policy option is to create demand for advanced coal generation. States could require utilities to sign long-term contracts for advanced coal generation, insuring funding and a market for the project developer while spreading costs across all participating utilities (and ratepayers). The primary project development risk would fall on the project owner but the contracts for generation could spread this risk as desired. Contract requirements could be set to develop a specific number of projects. Alternatively, a state or groups of states could establish an advanced coal portfolio standard, similar to the one Illinois has adopted.[67] This would create a guaranteed market for advanced coal generation with all ratepayers helping to pay for a portion of the project cost. If the developer is a vertically integrated utility, its ratepayers would pay the majority of the cost unless the price of portfolio credits rose significantly because of supply shortfalls. An advanced coal portfolio standard would likely create more competition than requirements to sign long-term contracts, and the developer would incur greater risk because of this competition.

Benefits of cooperation across multiple states

Although cooperation across multiple states is inherently more difficult than individual state action, a group of states working together would have significant advantages over individual state action. Sharing costs and risks across multiple states reduces rate impacts and makes financing multiple, full-scale demonstration projects feasible, whereas an individual state would face challenges with one project. In addition, costs of advanced coal projects and CO_2 demand sources are location-dependent. Proximity to a low-cost coal mine would lower project costs, and not all states have realistic CO_2 demand sources. A multistate solution would allow states without low-cost locations for advanced coal to make investments at a lower cost than they could within their state boundaries, and would spread costs and technical understanding and learning. Coal-dependent states are a combination of restructured market states and traditionally regulated states, potentially creating complications for cooperation across multiple states. However, most of the policy options listed above can be structured to work across restructured and traditionally regulated states.

[67] A Policy Strategy for Carbon Capture and Storage, IEA, Jan 2012

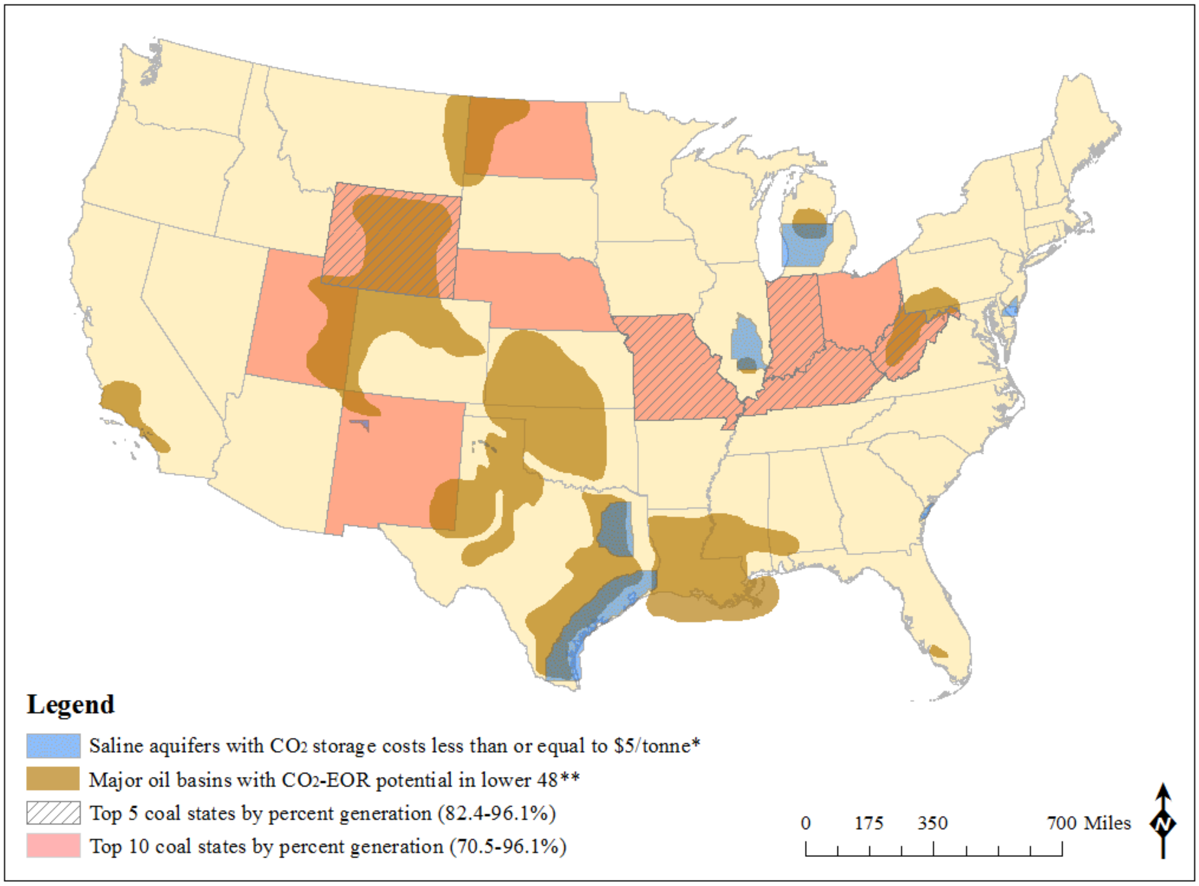

Figure 3. Map of deep saline aquifers, potential enhanced oil recovery areas, and top coal generation states.
* From Eccles et al., The impact of geologic variability on capacity and cost estimates for storing CO_2 in deep-saline aquifers, *Energy Economics* 34 (2012) 1569–1579.
** ARI for NRDC, 2010

6. Conclusions

Advanced coal generation faces significant but surmountable barriers, with or without significant federal support. States and utilities are moving forward with advanced coal projects with federal and state support, but additional projects are needed to advance the technology. Low natural gas prices, combined with CO_2 emissions risk and proposed GHG regulations, make investment in advanced coal projects by an individual utility or investor without public support unlikely. Furthermore, these trends make it increasingly difficult for public utility commissions in traditionally regulated states to approve ratepayer funding of demonstration projects. Despite this, utilities can address the utility commission concerns with demonstration projects outlined earlier by sharing project costs and benefits. In addition, states can adopt policies that promote investment in advanced coal and ensure that costs and benefits are shared widely. Statements by coal state representatives and coal utilities indicate a desire to invest in advanced coal technology, but successful investment will likely require innovative policies and cost sharing mechanisms.