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The FutureGen Carbon Capture and Sequestration Project: A Brief History and Issues for Congress

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Summary

More than a decade after the George W. Bush Administration announced its signature clean coal power initiative—FutureGen—the program is still in early development. Since its inception in 2003, FutureGen has undergone changes in scope and design. As initially conceived, FutureGen would have been the world's first coal-fired power plant to integrate carbon capture and sequestration (CCS) with integrated gasification combined cycle (IGCC) technologies. FutureGen would have captured and stored carbon dioxide (CO₂) emissions from coal combustion in deep underground saline formations and produced hydrogen for electricity generation and fuel cell research. Increasing costs of development, among other considerations, caused the Bush Administration to discontinue the project in 2008. In 2010, under the Obama Administration, the project was restructured as FutureGen 2.0: a coal-fired power plant that would integrate oxy-combustion technology to capture CO₂. FutureGen 2.0 is the U.S. Department of Energy's (DOE) most comprehensive CCS demonstration project, combining all three aspects of CCS technology: capturing and separating CO₂ from other gases, compressing and transporting CO₂ to the sequestration site, and injecting CO₂ in geologic formations for permanent storage.

Congressional interest in CCS technology centers on balancing the competing national interests of fostering low-cost, domestic sources of energy like coal against mitigating the effects of CO₂ emissions in the atmosphere. FutureGen 2.0 would address these interests by demonstrating CCS technology as commercially viable. Among the challenges to the development of FutureGen 2.0 are rising costs of production, ongoing issues with project development, lack of incentives for investment from the private sector, and time constraints. Further, FutureGen's development would need to include securing private sector funding to meet increasing costs, purchasing the power plant for the project, obtaining permission from DOE to retrofit the plant, performing the retrofit, and then meeting the goal of 90% capture of CO₂.

The FutureGen project was conceived as a public-private partnership between industry and DOE with agreements for cost-share and cooperation on development, demonstration, and deployment of CCS technology. The public-private partnership has been criticized for leading to setbacks in FutureGen's development, since the private sector lacks incentives to invest in costly CCS technology. Regulations, tax credits, or policies such as carbon taxation or cap-and-trade that increase the price of electricity from conventional power plants may be necessary to make CCS technology competitive enough for private sector investment. Even then, industry may choose to forgo coal-fired plants for other sources of energy that emit less CO₂, such as natural gas. However, Congress signaled its support for FutureGen 2.0 via the American Recovery and Reinvestment Act of 2009 (ARRA, P.L. 111-5) by appropriating almost \$1 billion for the project. ARRA funding will expire on September 30, 2015, and it remains a question whether the project will expend all of its federal funding before that deadline.

A proposed rule by the Environmental Protection Agency (EPA) to limit CO₂ emissions from new fossil-fuel power plants may provide some incentive for industry to invest in CCS technology. The debate has been mixed as to whether the rule would spur development and deployment of CCS for new coal-fired power plants or have the opposite effect. Multiple analyses indicate that there will be retirements of U.S. coal-fired capacity; however, virtually all analyses agree that coal will continue to play a substantial role in electricity generation for decades. The rapid increase in the domestic natural gas supply as an alternative to coal, in combination with regulations that curtail CO₂ emissions, may lead electricity producers to invest in natural gas-fired

plants, which emit approximately half the amount of CO₂ per unit of electricity produced compared to coal-fired plants.

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Introduction and Background

This report briefly summarizes the history of FutureGen, discusses why it has gained interest and support from some Members of Congress and the Administration while remaining in initial stages of development, and offers some policy considerations on barriers that challenge its further development as a model for a CCS program. A timeline history of FutureGen is found at the end of this report.

FutureGen is a clean-coal technology program managed through a public-private partnership between the U.S. Department of Energy (DOE) and the FutureGen 2.0 Industrial Alliance. The FutureGen program as originally conceived in 2003 by the George W. Bush Administration had the intent of constructing a net zero-emission fossil-fueled power plant with carbon capture and sequestration (CCS) technology.¹ CCS is a process envisioned to capture carbon dioxide (CO₂)—a greenhouse gas associated with climate change—emitted from burning fossil fuels and store it in deep underground geologic formations, thus preventing its release into the atmosphere. If widely deployed in the United States, CCS could decrease the amount of U.S.-emitted CO₂. In 2008, DOE withdrew from the FutureGen partnership, citing rising costs of construction as its reason. Subsequently, DOE restructured the FutureGen program to instead develop two or three demonstration projects at different power plants around the country. In 2010, the Obama administration announced another change to the program with the introduction of FutureGen 2.0, which would retrofit an existing fossil fuel power plant in Illinois with CCS technology.²

The FutureGen project was originally conceived as a cost-share between the federal government, which would cover 76% of the cost, and the private sector, which would provide the remaining 24%. Between FY2004 and FY2008, Congress appropriated \$174 million to the original FutureGen project. DOE obligated \$44 million and expended \$42 million between FY2005 and FY2010 toward the original project.³ Under the Obama Administration, Congress appropriated almost \$1 billion in the American Recovery and Reinvestment Act of 2009 (ARRA, P.L. 111-5) for FutureGen 2.0. Furthermore, DOE has obligated nearly \$60 million but has expended \$2 million from regular appropriations to FutureGen 2.0 since FY2010.⁴ Together with the approximately \$74 million expended on the project from ARRA funding (discussed below), total expenditures for FutureGen since its conception were between \$110 and \$120 million as of early 2014.

The FutureGen Industrial Alliance estimated the total cost of the FutureGen 2.0 program to be nearly \$1.3 billion, with \$730 million used toward retrofitting and repowering Ameren Corporation's power plant in Meredosia, Illinois, and \$550 million used for the construction of a CO₂ pipeline, storage site, and training and research center. In 2011, they estimated that the project would create approximately 1,000 construction jobs and another 1,000 jobs for suppliers across the state.⁵ A 2013 report from the University of Illinois predicted that the project could

¹ Congress first appropriated funds specifically for FutureGen in FY2005.

² U.S. Department of Energy National Energy Technology Laboratory, "Secretary Chu Announces FutureGen 2.0: Awards \$1 Billion in Recovery Act Funding for Carbon Capture and Storage Network in Illinois," press release, August 5, 2010, http://www.netl.doe.gov/publications/press/2010/10033-Secretary_Chu_Announces_FutureGen_.html.

³ Email correspondence with Jeff Hoffman of the Office of Major Demonstrations in the Department of Energy's National Energy Technology Laboratory.

⁴ Ibid.

⁵ FutureGen Alliance, "FutureGen 2.0," press release, February 24, 2011, <http://www.futuregenalliance.org/pdf/> (continued...)

create an average of 620 permanent jobs for 20 years and approximately \$12 billion of business volume by 2037 for the state of Illinois.⁶

DOE CCS Programs

Current scientific research associates an increase in atmospheric GHGs (in particular CO₂, methane, and nitrous oxides), which trap heat in the earth's atmosphere, with the potential for changing the Earth's climate. The increase in the atmospheric concentration of CO₂ in the 20th and 21st centuries is due almost entirely to human activities.⁷ If successful, FutureGen 2.0 would demonstrate a technology that, if widely deployed, could capture a significant fraction of U.S. CO₂ emissions for geologic sequestration.

DOE's Office of Fossil Energy directs three major CCS programs: the Clean Coal Power Initiative (CCPI), Industrial Carbon Capture and Storage (ICCS), and FutureGen 2.0.⁸ Through its CCPI program, DOE partners with industry leaders in a cost-share arrangement to develop new CCS technologies for power plant utilities in order to reduce greenhouse gas emissions by boosting plant efficiencies and capturing CO₂. Of the six projects selected under the most recent funding for CCPI (Round 3), three have withdrawn, citing concerns over costs and regulations. DOE's share for the three active projects is \$1.0 billion of a total \$6.1 billion, approximately 17%. DOE is also partnering with industry for 31 projects in the ICCS program, which supports R&D in a non-utility large-scale industrial CCS program and a program to support beneficial CO₂ use. The combined total DOE share for all the ICCS projects is \$1.422 billion of a total \$2.0 billion, approximately 70%.

FutureGen 2.0 is DOE's most comprehensive CCS demonstration project, combining all three aspects of CCS technology: capturing and separating CO₂ from other gases, compressing and transporting CO₂ to the sequestration site, and injecting CO₂ in geologic formations.

Current Status of FutureGen

In October 2010, FutureGen 2.0 developers began working on Phase 1 of the project with the Pre-Front End Engineering Design (Pre-FEED) report, which included plant design, estimated project cost, and basis for applying for National Environmental Policy Act (NEPA) review and other state and local permits.⁹ The report showed that the estimated price for FutureGen 2.0 had increased from \$1.3 billion to \$1.65 billion. Subsequently, cost reduction measures were

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FutureGenFacts.pdf.

⁶ University of Illinois, Institute of Government and Public Affairs, Regional Economics Applications Laboratory, *Economic Impacts of FutureGen 2.0 on Illinois and Local Economies*, Urbana, IL, June 2013, http://www.jredc.org/resources/Economic_Impact_FutureGen2%200_Hewings_6-2013_Final.pdf.

⁷ For a more detailed examination of the science of climate change, see CRS Report RL34513, *Climate Change: Current Issues and Policy Tools*, by Jane A. Leggett <http://www.crs.gov/pages/Reports.aspx?PRODCODE=RL34513>.

⁸ For a more detailed examination of DOE's CCS program, see CRS Report R42496, *Carbon Capture and Sequestration: Research, Development, and Demonstration at the U.S. Department of Energy*, by Peter Folger.

⁹ D. K. McDonald, M. Estopinal, and H. Mualim, "FutureGen 2.0: Where Are We Now?," (Technical Paper, Babcock & Wilcox Power Generation Group, Inc., 2012), pp. 2-3, <http://www.babcock.com/library/pdf/BR-1870.pdf>. (Hereinafter referred to as McDonald.) Babcock & Wilcox Power Generation Group is a technology provider for FutureGen 2.0 carbon capture project.

identified and implemented, including establishing the plant gross output at 168 MW (the steam turbine is nominally rated at 200 MW), and using a combination of 60% Illinois coal and 40% Powder River Basin (PRB) coal to reduce sulfur and chlorine emissions.¹⁰ Also, in late 2011 Ameren announced it was closing its power plant in Meredosia, Illinois, and discontinuing its cooperative agreement with DOE.¹¹ Following that announcement, the project was redesigned to reflect that the Alliance would take control of the capture process as well as the transportation and storage site. The Alliance is currently negotiating the purchase of parts of the Meredosia Energy Center from Ameren to continue with project development. **Figure 1** shows the location of the town of Meredosia, Illinois, the proposed pipeline route, and the proposed carbon sequestration site where the captured CO₂ would be injected underground and stored.

Figure 1. Map Showing the Town of Meredosia, IL, the Proposed Pipeline Route, and the Proposed CO₂ Sequestration Site



Source: The FutureGen Alliance, <http://www.futuregenalliance.org/futuregen-2-0-project/pipeline/>.

Notes: The proposed pipeline is approximately 30 miles long. Construction is anticipated to begin in the summer of 2014, according to the FutureGen 2.0 Industrial Alliance.

¹⁰ McDonald et al., 2012, p. 4.

¹¹ Tennille Tracy, "Ameren Quits FutureGen Pollution Project," *The Wall Street Journal*, November 28, 2011.

Throughout the summer and fall of 2012, the project continued to confront rising cost estimates, as well as challenges in negotiating a long-term power purchasing agreement with the state of Illinois.¹² However, the project has achieved several milestones since 2012 that could favor its future progress. In late December 2012, the Illinois Commerce Commission voted 3-2 to approve a power procurement plan for the state that requires utilities to purchase all the electricity generated by the FutureGen 2.0 facility for 20 years. That decision cleared a major hurdle for FutureGen 2.0, and the decision allows Commonwealth Edison and Ameren Illinois to collect costs for the project from the state's alternative retail electric suppliers.¹³ Opposition to the power procurement proposal stemmed primarily from those opposed to its potential to raise costs for retail customers.¹⁴

In February 2013, DOE approved the start of Phase 2 of the project, which includes final permitting and design activities that precede a decision to begin construction.¹⁵ The project faced delays while it was being redesigned following the release of the Pre-FEED report; however, the FEED activities resulted in a 70%-90% design completion for the project, which is better than the industry standard of about 25%, according to the FutureGen 2.0 Industrial Alliance.¹⁶

On October 25, 2013, DOE issued the final environmental impact statement (EIS) for FutureGen 2.0. The proposed action in the EIS is for DOE to provide funding of approximately \$1 billion to the FutureGen 2.0 Industrial Alliance to support the completion of Phase 2—preliminary and final design for the project—followed by construction and commissioning (Phase 3) and operations (Phase 4).¹⁷ On November 30, 2013, EPA published a notice of availability in the *Federal Register*,¹⁸ and on January 16, 2014, DOE issued a favorable record of decision (ROD), as part of the NEPA process. Issuance of the ROD clears the last hurdle in the NEPA process, and reportedly allows the FutureGen 2.0 Industrial Alliance to move forward pending approval of a permit to install the CO₂ injection wells and meeting financial requirements.¹⁹

¹² “At the Major CCS Projects: HECA, FutureGen,” *GHG Reduction Technologies Monitor*, July 20, 2012, <http://ghgnews.com/index.cfm/at-the-major-ccs-projects-futuregen-20-heca/?mobileFormat=false>. (Hereinafter referred to as GHG Reduction Technologies Monitor, July 20, 2012.)

¹³ Tamar Hallerman, “Ill. Regulators Approve 20-Year Power Contract for FutureGen,” *GHG Reduction Technologies Monitor*, December 21, 2012, <http://ghgnews.com/index.cfm/ill-regulators-approve-20-year-power-contract-for-futuregen/>. (Hereinafter referred to as GHG Reduction Technologies Monitor, December 21, 2012.)

¹⁴ GHG Reduction Technologies Monitor, December 21, 2012.

¹⁵ See FutureGen 2.0 Industrial Alliance, Community Corner Archive, <http://www.futuregenalliance.org/community-corner/2013/03/>.

¹⁶ Ken Humphreys, CEO of the FutureGen 2.0 Industrial Alliance, personal communication, April 18, 2013.

¹⁷ DOE, EIS-0460: *Final Environmental Impact Statement, FutureGen 2.0 Project, Morgan County, Illinois*, October 25, 2013, <http://energy.gov/nepa/downloads/eis-0460-final-environmental-impact-statement>.

¹⁸ Environmental Protection Agency, “EIS No. 20130314, Final EIS, DOE, IL, FutureGen 2.0, Project, Review,” 78 *Federal Register* 65643, November 30, 2013.

¹⁹ Christa Marshall, “FutureGen Gets Final Nod from DOE,” *ClimateWire*, January 17, 2014, which cites a statement by FutureGen Industrial Alliance CEO Ken Humphreys.

Policy Challenges and Issues for Congress

After more than 10 years and two restructuring efforts since FutureGen's inception, the project is still in its early development stages. Although the FutureGen 2.0 Industrial Alliance completed drilling a characterization well at the storage site in Morgan County, IL, and installed a service rig over the well for further geologic analysis, issues with the power plant itself have not yet been resolved. Among the remaining challenges are securing private sector funding to meet increasing costs, purchasing the Meredosia power plant from Ameren, obtaining permission from the DOE to retrofit the plant, performing the retrofit, and then meeting the goal of 90% capture of CO₂. In addition, the Alliance is awaiting approval for a Class VI well permit for the injection and sequestration wells.²⁰

Cost, Schedule, and Funding

Project Costs

Increasing projected costs have posed significant problems for FutureGen's development since 2003. Confronted with increasing projected costs in 2008, DOE under the George W. Bush Administration first restructured FutureGen, then postponed the program when cost projections rose from \$950 million to \$1.8 billion.

When Secretary of Energy Steven Chu announced the new FutureGen 2.0 in 2010, the cost was estimated at \$1.3 billion, with the DOE covering 80% of costs and industry partners contributing the remaining 20% of the total. Initially, FutureGen 2.0 was to be implemented through two separate cooperative agreements, with approximately \$590 million of ARRA funds allocated to Ameren Corporation to retrofit a power plant²¹ and approximately \$459 million of ARRA funds to the FutureGen 2.0 Industrial Alliance to implement a pipeline and regional CO₂ storage reservoir project.²²

According to the FutureGen 2.0 Industrial Alliance, total capital costs for the FutureGen 2.0 project are estimated to be \$1.65 billion.²³ The Alliance is expected to cover the additional cost

²⁰ The permit would be issued pursuant to the Safe Drinking Water Act, Underground Injection Control Program at EPA. The FutureGen Industrial Alliance has submitted applications for four Class VI CO₂ sequestration wells. See <http://www.epa.gov/r5water/uic/futuregen/>.

²¹ DOE partnered with Ameren to retrofit the corporation's obsolete 200 MW power plant in Meredosia, IL, with oxy-combustion technology. The plans are for the retrofitted power plant to capture 90% of emitted carbon dioxide and transport it from Meredosia to a storage site in Morgan County, IL, to store up 1.3 million tons of carbon dioxide per year. The portion of funding from ARRA is \$589,744,000. After Ameren withdrew from the cooperative agreement, the FutureGen Industrial Alliance took responsibility for the capture technology portion of the project as well as the pipeline and sequestration portion.

²² U.S. Department of Energy National Energy Technology Laboratory, *FutureGen 2.0*, Project Facts, June 2011, <http://www.netl.doe.gov>. Funds apportioned from the DOE to the FutureGen Alliance include \$404,985,000 from ARRA funds and \$53.6 million from prior year appropriations toward the FutureGen project through the Office of Fossil Energy.

²³ FutureGen 2.0 Alliance, "FutureGen 2.0, Frequently Asked Questions—General," December 2013, <http://www.futuregenalliance.org/wp-content/uploads/2013/12/FutureGen-FAQ-General-Dec-2013.pdf>. According to the July 2013 DOE FutureGen 2.0 Fact Sheet, the total cost of the project is estimated to be \$1,774,849,504, of which \$1,048,348,111 would be covered by DOE, and the remaining portion would be covered by the FutureGen Industrial Alliance. See <http://www.netl.doe.gov/publications/factsheets/project/FE0001882-FE0005054.pdf>. Some more recent (continued...)

beyond the original cost estimate for FutureGen 2.0. Rising costs of construction may continue to be a challenge to the project's development.

Schedule and Funding

Some projections for FutureGen predict construction on the power plant, pipeline, and storage facility will conclude by 2017.²⁴ A looming question is whether the FutureGen 2.0 Alliance will have sufficient time to expend the nearly \$995 million of ARRA funding appropriated by Congress for the project before it expires on September 30, 2015. As of October 2013, the FutureGen 2.0 Alliance has expended about \$73.97 million, or about 7.4%, of the total \$994,729,000 appropriated under ARRA.²⁵

Once construction begins, the rate of spending will undoubtedly increase. Now that the DOE ROD has been issued, it is likely that construction will begin sometime in spring or early summer of 2014. But even if construction began as early as March 2014, the project would need to spend approximately \$921 million over 19 months, or about \$48 million per month until the end of September 2015 to exhaust all the ARRA funding. According to the investigatory work of one industry observer, using documents obtained from DOE under a Freedom of Information Act request, DOE would grant the Alliance the flexibility to accelerate the cost-share and expend the ARRA-provided funding to cover capital costs before using private funds from the Alliance to cover its portion of the cost-share.²⁶ According to the report, DOE would require an increased level of oversight over the project to safeguard the public investment in the project. Further, DOE would have the ability to suspend or terminate funding if the project failed to demonstrate sufficient progress.²⁷

Public-Private Partnership

The partnership between the federal government and the private sector in funding and developing FutureGen has been marked by a series of setbacks and challenges. Some critics of the public-private partnership attribute the project's decade-long stasis to a lack of incentives for industry leaders to invest seriously in clean coal technologies. A report released by the Massachusetts Institute of Technology in 2007 stated that government investment and leadership in carbon capture technologies are necessary: "Given the technical uncertainty and the current absence of a carbon charge, there is no economic incentive for private firms to undertake such projects."²⁸ Since the MIT report was published, Congress has appropriated nearly \$7 billion in CCS research

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reports put the project cost at \$1.68 billion, see Christa Marshall, "FutureGen Gets Final Nod from DOE," *ClimateWire*, January 17, 2014.

²⁴ McDonald et al., 2012, p. 4.

²⁵ Recovery.gov website, FutureGen Industrial Alliance, Inc., October 2013, <http://www.recovery.gov/arra/Transparency/RecoveryData/Pages/Recipient.aspx?duns=603703799>.

²⁶ Tamar Hallerman, "DOE, FutureGen Eye Tight Project Timeline," *GHG Reduction Technologies Monitor*, October 25, 2013, <http://ghgnews.com/index.cfm/vol-8-issue-46/doe-futuregen-alliance-eye-tight-project-timeline/>.

²⁷ Ibid.

²⁸ Massachusetts Institute of Technology, *The Future of Coal: An Interdisciplinary MIT Study* (2007), p. xiii.

and development (R&D), including FutureGen; however, Congress has not enacted any form of a “carbon charge,” through either a cap-and-trade system or a carbon tax.²⁹

Ameren Corporation, which partnered with DOE to retrofit its power plant in Meredosia, IL, for FutureGen 2.0, discontinued operations at the Meredosia Energy Center where the plant is located, stating that it would not be able to afford the costs to comply with air pollution rules issued in July 2011 by the EPA to reduce sulfur dioxide and nitrogen oxide.³⁰ In addition to the FutureGen project, DOE partnered with industry for six other commercial-scale CCS projects through its Clean Coal Power Initiative (CCPI) program.³¹ The 2010 DOE Strategic Plan report predicted that at least five of DOE’s major CCS projects would become operational by 2016.³² Since the report was released, three of the six industry partners of CCPI projects have pulled out of agreements with DOE. The departure of several industry leaders from contracts with DOE demonstrates the volatility of the public-private partnership model.

EPA Proposed Rule to Limit CO₂ from New Power Plants

On September 20, 2013, the U.S. Environmental Protection Agency (EPA) re-proposed a standard that would limit emissions of carbon dioxide (CO₂) from new fossil-fueled power plants. As re-proposed, the rule would limit emissions to no more than 1,100 pounds per megawatt-hour of production from new coal-fired power plants and between 1,000 and 1,100 pounds per megawatt-hour (depending on size of the plant) for new natural gas-fired plants. EPA proposed the standard under Section 111 of the Clean Air Act. According to EPA, new natural gas-fired stationary power plants should be able to meet the proposed standard without additional cost and the need for add-on control technology. However, new coal-fired plants would be able to meet the standard only by installing carbon capture and sequestration (CCS) technology to capture about 40% of the CO₂ they typically produce. The proposed standard allows for a seven-year compliance period for coal-fired plants but would demand a more stringent standard for those plants that limits CO₂ emissions to an average of 1,000-1,050 pounds per megawatt-hour.³³

On January 8, 2014, EPA published the re-proposed rule in the *Federal Register*.³⁴ Publishing in the *Federal Register* triggers the start of a 60-day public comment period: comments will be accepted until March 10, 2014. The initial 2012 proposal generated more than 2.5 million

²⁹ Philip Webre and Samuel Wice, *Federal Efforts to Reduce Cost of Capturing and Storing Carbon Dioxide*, Congressional Budget Office, June 2012, p.5, <http://www.cbo.gov/sites/default/files/cbofiles/attachments/43357-06-28CarbonCapture.pdf>.

³⁰ Ameren Energy Resources Company, LLC, “Two Ameren Merchant Generating Company Energy Centers to Cease Operations,” press release, October 4, 2011, <http://ameren.mediaroom.com/index.php?s=43&item=981>. In January 2013 Ameren Energy Resources agreed to sell a portion of the Meredosia Energy Center to the FutureGen 2.0 Alliance for the FutureGen 2.0 project. Ownership is expected to formally transfer to the FutureGen 2.0 Alliance in 2014 prior to the start of construction of the and if all contractual conditions are met. See <http://www.futuregenalliance.org/community-corner/2013/03/>.

³¹ See CRS Report R42496, *Carbon Capture and Sequestration: Research, Development, and Demonstration at the U.S. Department of Energy*, by Peter Folger.

³² Steve Koonin, DOE Strategic Plan, U.S. Department of Energy, December 8, 2010, p. 8, http://efcog.org/library/council_meeting/SAMtg.120810/Presentations/Koonin,%20Steve.pdf.

³³ The proposal and background information is available at <http://www2.epa.gov/carbon-pollution-standards/2013-proposed-carbon-pollution-standard-new-power-plants>.

³⁴ Environmental Protection Agency, “Standards of Performance for Greenhouse Gas Emissions From New Stationary Sources: Electric Utility Generating Units,” 79 *Federal Register* 1429, January 8, 2014.

comments, which prompted, in part, the September 20, 2013, re-proposal. Promulgation of the final rule could be expected sometime after the public comment period ends and EPA evaluates the comments.

The re-proposed rule would address only new power plants. However, Section 111 of the Clean Air Act requires that EPA develop standards for greenhouse gas emissions for existing plants whenever it promulgates standards for new power plants. In his June 25, 2013, memorandum, President Obama directed the EPA to issue proposed standards for existing plants by June 1, 2014, and to issue final rules a year later.

Given the pending EPA rule, congressional interest in the future of coal as a domestic energy source appears directly linked to the future of CCS. The history of CCS research, development, and deployment (RD&D) at DOE and the pathway of its signature program—FutureGen—invite questions about whether DOE-funded RD&D will enable widespread deployment of CCS in the United States within the next decade.

The Natural Gas Alternative?

When EPA first proposed a new rule regulating GHG emissions from power plants that would likely require CCS, Congress considered legislation to block the new regulations. For example, the Subcommittee on Energy and Power of the House Science, Space, and Technology Committee held a hearing on June 19, 2012, where opponents of the new rule, including FutureGen Alliance Chairman Steven E. Winberg, criticized the regulations: “In effect, EPA’s rule will eliminate any new coal for years to come because EPA is requiring new coal-fueled power plants to meet a natural gas equivalent CO₂ standard, before CCS technology is commercially available.”³⁵

Following the September 20, 2013, re-proposal of the rule, the debate has been mixed as to whether the rule would spur development and deployment of CCS for new coal-fired power plants or have the opposite effect. Multiple analyses indicate that there will be retirements of U.S. coal-fired capacity; however, virtually all analyses agree that coal will continue to play a substantial role in electricity generation for decades. How many retirements would take place and the role of EPA regulations in causing them are matters of dispute.³⁶

Since the September 2013 re-proposal, the argument over the rule has focused, in part, on whether CCS is the best system of emissions reduction (BSER) for coal plants and whether it has been “adequately demonstrated” as such, as required under the Clean Air Act. In its re-proposed rule, EPA cites the “existence and apparent ongoing viability” of several ongoing CCS demonstration projects as examples that justify a separate determination of BSER for coal-fired plants and integrated gasification combined-cycle plants. (The second BSER determination is for gas-fired power plants.)³⁷ The EPA noted that these projects had reached advanced stages of

³⁵ U.S. Congress, House Committee on Energy and Commerce, Subcommittee on Energy and Power, *The American Energy Initiative: A Focus on EPA’s Greenhouse Gas Regulations*, 113th Cong., 1st sess., June 19, 2012, testimony of Steven E. Winberg, Vice-President, Research and Development, CONSOL Energy, Inc., p. 6.

³⁶ For a detailed discussion of the EPA’s regulation of coal, see CRS Report R41914, *EPA’s Regulation of Coal-Fired Power: Is a “Train Wreck” Coming?*, by James E. McCarthy and Claudia Copeland.

³⁷ The projects cited in the re-proposed rule are the Southern Company Kemper County Energy Facility, the SaskPower Boundary Dam CCS project, the Summit Power Texas Clean Energy Project, and the Hydrogen Energy California Project. The Boundary Dam project is a Canadian venture; the other three projects are in the United States and are (continued...)

construction and development, “which suggests that proposing a separate standard for coal-fired units is appropriate.” FutureGen 2.0 was not included as one of the projects used to justify the proposed rule, despite its 10-year long history and more than \$1 billion in committed federal support. Its omission from the EPA re-proposed rule further reinforces FutureGen’s status as a CCS project in the early stages of development.

The huge increase in the U.S. domestic supply of natural gas, due largely to the exploitation of unconventional shale gas reservoirs through the use of hydraulic fracturing, has also led to a shift to natural gas for electricity production.³⁸ The shift appears to be largely due to the cheaper and increasingly abundant fuel—natural gas—compared to coal for electricity production. The EPA re-proposed rule, discussed above, noted that “power companies often choose the lowest cost form of generation when determining what type of new generation to build. Based on [Energy Information Administration] modeling and utility [Integrated Resource Plans], there appears to be a general acceptance that the lowest cost form of new power generation is [natural gas combined-cycle].” Cheap gas, due to the rapid increase in the domestic natural gas supply as an alternative to coal, in combination with regulations that curtail CO₂ emissions, may lead electricity producers to invest in natural gas-fired plants, which emit approximately half the amount of CO₂ per unit of electricity produced compared to coal-fired plants. Regulations and abundant cheap gas may raise questions about the rationale for CCS demonstration projects like FutureGen.

Alternatively, and despite increasingly abundant domestic natural gas supplies, EPA regulations could provide the necessary incentives for the industry to accelerate CCS development and deployment for coal-fired power plants. As part of its re-proposed ruling, EPA cites technology as one of four factors that it considers in making a BSER determination.³⁹ Specifically, EPA stated that it “considers whether the system promotes the implementation and further development of technology,” in this case referring to CCS technology. It appears that EPA asserts that its rule would likely promote CCS development and deployment rather than hinder it. Those arguing against the re-proposed rule do so on the basis that CCS technology has not been adequately demonstrated, and that it violates provisions in P.L. 109-58, the Energy Policy Act of 2005, that prohibit EPA from setting a performance standard based on the use of technology from certain DOE-funded projects, such as the three projects cited in the EPA re-proposal, among other reasons.⁴⁰

On January 9, 2014, Representative Whitfield and 62 cosponsors introduced H.R. 3826, the Electricity Security and Affordability Act, which would essentially impose a number of requirements to be met before EPA could issue greenhouse gas emission regulations under Section 111 of the Clean Air Act, such as the EPA re-proposed rule discussed above. On January 14, 2014, the Energy and Power subcommittee, House Energy and Commerce committee, voted

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receiving funding from DOE. See CRS Report R42496, *Carbon Capture and Sequestration: Research, Development, and Demonstration at the U.S. Department of Energy*, by Peter Folger for more information on DOE funding for CCS.

³⁸ For a detailed discussion of how natural gas is affecting electric power generation, see CRS Report R42814, *Natural Gas in the U.S. Economy: Opportunities for Growth*, by Robert Pirog and Michael Ratner.

³⁹ The other three are feasibility, costs, and size of emission reductions.

⁴⁰ See for example, the November 15, 2013, letter to EPA Administrator Gina McCarthy from Rep. Fred Upton, chair of the House Committee on Energy and Commerce, http://www.eenews.net/assets/2013/11/22/document_daily_03.pdf; and the December 19, 2013, letter to Administrator McCarthy from Rep. Lamar Smith, chair of the House Committee on Science, Space, and Technology, http://science.house.gov/sites/republicans.science.house.gov/files/documents/Letters/121913_mccarthy.pdf.

to report the bill. Much of the discussion during the bill's markup centered on whether CCS was an adequately demonstrated technology to meet the requirements of the Clean Air Act.

Outlook

Congressional consideration of CCS has focused on balancing competing national interests, such as fostering low-cost domestic sources of energy like coal versus reducing greenhouse gas (GHG) emissions in the atmosphere. Legislative proposals during the 109th and 110th Congresses focused on advancing carbon capture technologies that reduce CO₂ emissions to mitigate GHG-induced global warming. Congress began appropriating funds specifically for FutureGen beginning in 2005. Previously, DOE had allocated funds under its Clean Coal Power Initiative (CCPI) program. With the American Recovery and Reinvestment Act of 2009, Congress appropriated approximately \$1 billion for the FutureGen 2.0 project.

The revival of FutureGen under the Obama Administration as FutureGen 2.0 has sparked increased scrutiny of the future of integrated CCS technology on a commercially viable scale. FutureGen was originally proposed to demonstrate the feasibility of using CCS technology to mitigate CO₂ emissions into the atmosphere. Among the challenges that continue to influence the development of FutureGen 2.0 are rising costs of construction, ongoing issues with project development, lack of incentives for investment from the private sector, and time constraints on project development. Despite congressional and Obama Administration commitments to the FutureGen 2.0 project, particularly the \$1.0 billion appropriation from ARRA, questions remain as to whether or not FutureGen 2.0 will succeed.

The Congressional Budget Office (CBO) published a report in June 2012 stating that the success of CCS technology depends on reducing technical costs, ensuring the effectiveness of CCS, and adopting policies that provide incentives for industry to pursue the high-cost demonstration technologies.⁴¹ The report explained that if regulations, tax credits, or policies such as carbon taxation or cap-and-trade that increase the price of electricity from conventional power plants are adopted, then CCS technology may become competitive enough for private sector investment. Even then, industry may choose to forgo coal-fueled plants for natural gas or other sources that emit less CO₂ compared to coal, according to CBO.⁴²

Timeline

The timeline that follows shows a chronology of the history of FutureGen since 2003.

⁴¹ Philip Webre and Samuel Wice, *Federal Efforts to Reduce Cost of Capturing and Storing Carbon Dioxide*, Congressional Budget Office, June 2012, pp. 14-15, <http://www.cbo.gov/sites/default/files/cbofiles/attachments/43357-06-28CarbonCapture.pdf>.

⁴² Several CRS reports cover the issues of technology and cost of capturing CO₂, as well as the challenge of storage capacity in the United States for captured CO₂, regulatory challenges, public acceptance, and others. See CRS Report R41325, *Carbon Capture: A Technology Assessment*, by Peter Folger; CRS Report R42532, *Carbon Capture and Sequestration (CCS): A Primer*, by Peter Folger; CRS Report RL34601, *Community Acceptance of Carbon Capture and Sequestration Infrastructure: Siting Challenges*, by Paul W. Parfomak, and others.

PHASE 1

2003

February 27: President George W. Bush proposed a 10 year, \$1 billion project to build a 275 MW coal-fired power plant that would integrate carbon sequestration and hydrogen production.

2004

March: In its 2004 Report to Congress, the DOE estimated that FutureGen would cost \$950 million with the DOE contributing 76% and the private sector the remaining 24% of the total cost.

July: The FutureGen Industrial Alliance, a non-profit company composed of the largest international coal companies and electric utilities, was formed to partner with the DOE on the development of FutureGen. The seven founding Alliance members are American Electric Power, BHP Billiton, CONSOL Energy Inc., Foundation Coal Corporation, Kennecott Energy Company (a member of the Rio Tinto group), Peabody Energy, and Southern Company.

2005

October 27: China Huaneng Group, China's largest coal-fueled power generator, joined the Alliance.

December: The DOE and the Alliance signed a Cooperative Agreement partnering in all development aspects of the \$1 billion FutureGen project, including site and technology selection, construction and operation.

2006

February 23: Anglo American, one of the world's largest diversified mining and natural resource groups, joined the FutureGen Industrial Alliance as its ninth member.

March 8: The Alliance released the final Request for Proposals (RFP) for regions interested in hosting the world's first coal-fueled "zero emissions" power plant.

May 23: PPL Corporation, an electric company delivering electricity and natural gas in the United States and United Kingdom, joined the FutureGen Industrial Alliance as its tenth member.

July 25: The Alliance selected four finalist hosting sites for FutureGen: Mattoon, IL, Tuscola, IL, Odessa, TX and Jewett, TX.

October 31: E.ON US, the world's largest investor-owned electric utility service provider, joined the Alliance as its eleventh member.

December 7: Xstrata Coal, Australia-based exporter of high energy thermal coal, joined the Alliance as its twelfth member.

December 15: The United States and China announced their cooperation on FutureGen and signed an Energy Efficiency Protocol during the first U.S.-China Strategic and Economic Dialogue.

2007

January: The Alliance produced an initial conceptual design report for the original FutureGen project estimating the cost of the program at \$1.8 billion accounting for inflation through 2017.

March 23: The DOE and Alliance signed a Cooperative Agreement stipulating that the DOE would cover 74% and the Alliance would share the remaining 26% of the \$1.8 billion cost.

May 25: The DOE released a Draft Environmental Impact Statement (DEIS) that included a review of all four candidate sites in Illinois and Texas.

November 9: The DOE released a final Environmental Impact Statement (EIS) predicting program costs at \$1.8 billion with projected revenues from the sale of electricity at \$301 million.

December: Given rising costs of FutureGen development, DOE's Office of Fossil Energy attempted to negotiate a new cost-sharing arrangement with the Alliance before continuing the cooperative agreement in June 2008.

December 6: Luminant, a Texas-based electric utility, joined the Alliance as the thirteenth member.

December 10: The DOE advised the Alliance not to announce the selected plant site.

December 11: Peabody Energy, a founding member of the Alliance, became an equity partner in China's \$1 billion GreenGen project, an envisioned near-zero emission carbon capture project modeled after FutureGen. Peabody has a 6% stake in GreenGen.

December 18: The Alliance announced its selection of Mattoon, IL as the final site to host the FutureGen power plant.

2008

January 8: Alliance board of directors elected Paul W. Thompson of E.ON U.S. as its next chairman of the board to replace outgoing chairman Greg A. Walker.

PHASE 2

April 9: Alliance CEO Michael J. Mudd told the Senate Subcommittee on Science, Technology and Innovation that DOE's recent proposal to restructure FutureGen failed to address the challenges of climate change and energy security and would delay CCS technology by several years.

April 15: Alliance Chairman Paul Thompson testified before the House Science and Technology Committee that costs of all global energy infrastructure projects increased due to inflation. Thompson said that FutureGen costs were consistent with industry average increases.

May 7: The DOE released a draft Funding Opportunity Announcement for restructured FutureGen to receive public input and gauge public interest in the project.

May 8: Secretary of Energy Samuel Bodman testified before the Senate Subcommittee on Energy and Water Development that the cost of the FutureGen project doubled from \$950 million to \$1.8 billion. Alliance Chairman Paul Thompson told members of the subcommittee to continue supporting the original FutureGen project in Mattoon, IL because of predicted delays and reduced standards of CO₂ capture in DOE's restructured FutureGen project. The Senate subcommittee held the oversight hearing to discuss DOE's decision to restructure FutureGen.

PHASE 2 CONT

May 19: Senators Kit Bond (R-MO) and Dick Durbin (D-IL) sent a letter to Secretary of Energy Samuel Bodman to extend the budget period of the existing cooperative agreement from June 15, 2008 to March 30, 2009 in order to retain funds already appropriated for FutureGen, maintain the original FutureGen program and allow the incoming administration to make a decision on the future of FutureGen.

June: Senior DOE officials directed the Office of Fossil Energy to negotiate a new cost-sharing agreement with the Alliance under the Cooperative Agreement that was scheduled for a continuation in June. The negotiations failed to yield an agreement.

June: The DOE formally discontinued its cost-share with the Alliance for FutureGen. Luminant and PPL Corporation pulled out of the FutureGen Alliance.

July: The Senate Energy and Water Appropriations Subcommittee approved a measure that would maintain \$134 million in prior year appropriations for FutureGen at Mattoon, IL.

July: Southern Illinois University's Clean Coal Review Board voted to award \$2 million in grants for the FutureGen project for gasification, plant production and plant efficiency studies. The Alliance matched the grant and spent approximately \$6 million on engineering and cost control studies.

December 12: The Alliance and Coles Together, a non-profit economic development organization in Coles County where FutureGen would be built, combined funds to purchase more than 420 acres of land in Mattoon, IL for approximately \$7 million.

PHASE 3**2009**

January 29: A bipartisan group of senators including Dick Durbin (D-IL), Kit Bond (R-MO), Claire McCaskill (D-MO) urged Secretary Chu to release the Record of Decision (ROD) certifying that a \$1.8 billion coal-fueled experimental power plant would be built in Mattoon, IL.

February: A Government Accountability Office report showed that the DOE miscalculated the cost of FutureGen at \$1.8 billion. GAO showed that in constant 2005 dollars from DOE's predicted cost estimate of \$950 million, the Alliance's predicted cost for FutureGen increased by 37% or \$370 million to \$1.3 billion by 2017.

February 17: The American Recovery and Reinvestment Act provided \$1.073 billion to the FutureGen program to advance construction of a plant built in Mattoon, IL.

June: Southern Company withdrew from the Alliance stating its intention to focus on coal gasification in its Kemper County, MS power plant and a carbon research center in Wilsonville, Alabama.

June 12: The Alliance and DOE reached an agreement to proceed with the preliminary design and cost estimate of FutureGen, estimated at \$2.4 billion.

July 1: American Electric Power pulled out of the Alliance stating that FutureGen was moving too slowly and the company wanted to focus on carbon-sequestration projects like the Mountaineer plant in West Virginia.

July 14: The DOE issued the ROD, a final public decision that certifies that the Mattoon, IL site meets environmental requirements for the project.

September 2: The Alliance board of directors elected Steven Winberg of CONSOL Energy Inc. as the new chairman of the board to replace outgoing chairman Paul Thompson.

2010

January 12: The Illinois Finance Authority passed a resolution (Resolution Number 2010-01-09) providing the necessary financial mechanisms to issue bonds to help fund FutureGen.

January 30: Exelon Corporation, one of the nation's largest electric utilities, joined FutureGen Alliance.

February 8: Caterpillar Inc., a world-leading manufacturer of construction and mining equipment, joined the FutureGen Alliance.

PHASE 4

August 5: Secretary Chu announced the administration's new FutureGen 2.0 project, which would retrofit Ameren's existing power plant in Meredosia, IL with oxy-combustion technology at a 202 MW oil-fired unit. FutureGen 2.0 would be funded by \$1 billion stimulus money and \$247 million in private funds.

August 11: After DOE announced that Mattoon, IL would serve as the storage site for CO₂ captured in Meredosia, IL, Coles Together removed Mattoon from participation in the FutureGen 2.0 project.

August 31: The Alliance Board of Directors offered support to DOE on its new FutureGen 2.0 program if mutual agreement on terms and conditions could be reached in fall, 2010.

September 28: DOE signed final cooperative agreements with the Alliance and Ameren Energy Resources that formally commit \$1 billion in ARRA funds.

October 25: The Alliance issued requests for regions to submit proposals for hosting the carbon dioxide storage site.

December 20: Four Illinois counties (Christian County, Douglas County, Fayette County and Morgan County) were selected to advance to the next stage of site selection.

PHASE 4 CON'T

2011

February 28: The Alliance announced that it had selected Morgan County, IL as the location for the FutureGen 2.0 storage site.

April 5: The Alliance created FutureGen Citizens' Board to receive community feedback on geologic storage of CO₂ and on visitors and training facilities.

June 7-9: DOE held public hearings in Taylorville, Tuscola and Jacksonville, IL about the environmental effects of storing carbon dioxide under these communities.

August 23: Illinois Legislature passed the "Carbon Dioxide Transportation" (S.B. 1821) legislation to aid with pipeline construction from Meredosia to the storage site in Morgan County.

October: The Alliance completed Phase 1: Pre-Front End Engineering Design (Pre-FEED) work which included plant design, estimated project cost and basis for applying for NEPA and other permits. The Pre-FEED report showed that the price of FutureGen increased from \$1.3 billion to \$1.65 billion.

October 4: Ameren said it will close its Meredosia and Hutsonville plants in Illinois because it could not afford to implement EPA regulations issued in July to reduce sulfur dioxide by 73% and nitrogen oxide by 54% from 2005 levels.

October 14: Developers began drilling a test well of about 5,000 feet in Springfield in Morgan County, IL. The plan is to pump carbon dioxide into the well in 2016.

October 31: Illinois Legislature passed "Clean Coal FutureGen for Illinois Act of 2011" (S.B. 2062) addressing liability management and "providing the FutureGen Alliance with adequate liability protection, land use rights, and permitting certainty to facilitate the siting of the FutureGen Project in Illinois."

November 28: The Alliance negotiated an option to purchase portions of the Meredosia Energy Center from Ameren in order to continue the development of the FutureGen 2.0 power plant.

December 20: The FutureGen Alliance successfully completed drilling a 5,000 foot characterization well in Morgan County, IL and preliminary data indicated that the local geology is suitable for carbon dioxide storage.

2012

January 26: A service rig was installed over the well in order to conduct hydrologic and geologic testing.

January 26: The Alliance finalized the sale of land originally purchased from Coles Together for the original FutureGen project. The conclusion of this transaction will allow Coles Together to continue to pursue economic development opportunities for the site and the Alliance will redirect funds from the sale to the FutureGen 2.0 project in Morgan County.

April: A revised Phase 1 report was submitted to the DOE with changes in project structure and schedule. The plant was rescaled to 168 MW capacity and the start of commercial operations changed from late 2015 to 2017.

July: After months of geologic and engineering studies, the Alliance confirmed Morgan County, IL as FutureGen 2.0's CO₂ sequester site (the Alliance was considering Christian and Douglas Counties as alternative sequestration sites). The Alliance secured underground rights and began its application to the EPA for a CO₂ storage permit.

December: The Illinois Commerce Commission voted 3-2 to approve a power procurement plan for the state that requires utilities to purchase all the electricity generated by the FutureGen 2.0 facility for 20 years. The order requires Commonwealth Edison and Ameren Illinois to purchase all of the gross electricity generated at the FutureGen 2.0 facility beginning in 2017.

2013

February: DOE approves the start of Phase 2 of the FutureGen 2.0 project.

February 28: The Illinois Competitive Energy Association, which represents alternative retail electric suppliers in the state, filed notice with the Illinois Appellate Court that it would challenge FutureGen's sourcing agreement, approved by the Illinois Commerce Commission (ICC) by a 3-2 vote in December. Commonwealth Edison (ComEd), one of the state's two main utilities, also announced its plans to challenge the sourcing agreement.

September 20: The U.S. Environmental Protection Agency (EPA) re-proposes a standard that would limit emissions of CO₂ from new fossil fueled power plants. The re-proposed rule virtually requires that new coal-fired power plants install CCS to meet the new emissions standards.

October 25: DOE issues the Final Environmental Impact Statement (EIS) for the FutureGen 2.0 project.

2014

January 8: EPA publishes the re-proposed rule for limiting emissions from new power plants in the Federal Register, triggering a 60-day public comment period.

January 16: DOE issued a favorable Record of Decision (ROD) for FutureGen as part of the National Environmental Policy Act (NEPA) process.

2015

September 30: ARRA award expires

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