FUTUREGEN AND THE DEPARTMENT OF ENERGY'S ADVANCED COAL PROGRAMS

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

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CONTENTS

March 11, 2009

Appendix 1: Answers to Post-Hearing Questions

Appendix 2: Additional Material for the Record

FUTUREGEN AND THE DEPARTMENT OF ENERGY'S ADVANCED COAL PROGRAMS

WEDNESDAY, MARCH 11, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Brian Baird [Chair of the Subcommittee] presiding.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE AND TECHNOLOGY

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Hearing On

FutureGen and the Department of Energy's Advanced Coal Programs

Wednesday, March 11, 2009
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

WITNESSES LIST

Dr. Victor Der
Acting Assistant Secretary
Office of Fossil Energy, U.S. Department of Energy

Mr. Mark Gaffigan
Director
Natural Resources and Environment Team
U.S. Government Accountability Office

Dr. Robert J. Finley
Director
Energy and Earth Resources Center
Illinois State Geological Survey

Mr. Larry Monroe
Senior Research Consultant
Southern Company

Ms. Sarah Forbes
Senior Associate
Climate and Energy Program, World Resources Institute

HEARING CHARTER

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

FutureGen and the Department of Energy's Advanced Coal Programs

WEDNESDAY, MARCH 11, 2009
10:00 A.M.–12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Wednesday, March 11th at 10:00 a.m. the House Committee on Science and Technology, Subcommittee on Energy and Environment will hold a hearing entitled *"FutureGen and the Department of Energy's Advanced Coal Programs."* The purpose of the hearing is to receive testimony on near-term and long-term strategies to accelerate research, development and demonstration of advanced technologies to help reduce greenhouse gas emissions from new and existing coal-fired power plants.

The Subcommittee will hear testimony from five witnesses who will speak about advanced coal technology projects ongoing in the United States as well as new initiatives under consideration here and around the globe. Witnesses will also address the technical challenges and policy hurdles confronting the wide scale deployment of carbon capture and storage systems.

Witnesses

1. **Dr. Victor Der:** Acting Assistant Secretary for the Department of Energy's Office of Fossil Energy will discuss the status and goals of the Department's advanced coal programs. He also will describe the Department's plans for expenditure of funds allocated under the *American Recovery and Reinvestment Act of 2009* and explain the Department's role to facilitate international collaboration regarding CCS technologies.
2. **Mr. Mark Gaffigan:** Director, Natural Resources and Environment Team at the U.S. Government Accountability Office (GAO). Mr. Gaffigan will summarize the GAO's report on the restructured FutureGen program and the conclusions to be drawn for a path forward on CCS policy decisions.
3. **Dr. Robert J. Finley:** Director, Energy and Earth Resources Center for Illinois State Geological Survey with specialization in fossil energy resources. He is currently heading a regional carbon sequestration partnership in the Illinois Basin aimed at addressing concerns with geological carbon management. Dr. Finley will provide an update on activities at the Midwest Geological Sequestration Consortium and provide information about the injection site selection process and strategies for monitoring the site.
4. **Mr. Larry Monroe:** Senior Research Consultant at Southern Company. Mr. Monroe will discuss carbon capture and storage projects his company has underway and some of the technical challenges and other barriers to the deployment of CCS systems on a commercial scale.
5. **Ms. Sarah Forbes:** Senior Associate, Climate and Energy Program at the World Resources Institute. Ms. Forbes will discuss the World Resources Institute's ongoing activities to establish guidelines and recommendations for the deployment of carbon capture and storage technologies. She will describe ongoing activities and new initiatives underway to facilitate international collaboration on advanced coal technologies and the benefits and challenges associated with widespread demonstration and commercial application of CCS programs.

Background

The Department of Energy (DOE) manages a number of different programs designed to research and develop technologies to meet the goal of reducing greenhouse gas emissions from our nation's coal-fired power plants and other industrial sources. The Department's programs include the Clean Coal Power Initiative, FutureGen, Innovations for Existing Plants Program, the Advanced Turbines Program, the Advanced Integrated Gasification Combined Cycle Program, and the Carbon Sequestration Regional Partnerships to name some of the specific programs that aim to improve power plant efficiencies, advance the development of carbon capture and storage technologies and reduce the costs of these technologies. In addition, the Department leads U.S. Government participation in the Carbon Sequestration Leadership Forum that was established in 2003 and is comprised of twenty-one countries and the European Commission. Its goal is to facilitate the development of cost-effective technologies and strategies for CO_2 separation, capture and long-term storage and to make these tools broadly available around the globe.

It is well known that approximately 50 percent of the electricity generation in the United States comes from coal. On a global scale, approximately 41 percent of the electricity production is from coal.[1] It is also well understood that the burning of fossil fuels contributes significantly to greenhouse gas emissions. The International Energy Agency (IEA) 2008 report states, "The CO_2 concentration in the atmosphere is 385 ppm, and is rising by about two ppm per year."[2] The IEA further states that "[S]tationary CO_2 sources associated with fossil-fuel energy use produce the bulk of the world's CO_2 emissions." Specifically, the IEA report finds that electricity and heat production produced 9.6 Gt of CO_2 in 2005 out of a total 26.3 Gt.[3]

As we move to adopt policies to reduce greenhouse gas emissions in the United States, the electricity generating sector of our economy certainly will be one target to achieve those emissions reductions. While the details of a national climate change program are unknown at this time, there is much discussion about the suite of practices we must adopt and the portfolio of technologies we must deploy to meet the daunting challenge of climate change. As part of that discussion there is growing interest in determining how significant a role carbon capture and storage systems can play in managing greenhouse gas emissions from coal-fired power plants.

Carbon Capture

There are three main technology options for capturing CO_2 from power plants or other industrial facilities: 1) post-combustion capture, 2) pre-combustion capture, and 3) oxy-fuel combustion capture.

Post-combustion processes captures the CO_2 from the exhaust gas through the use of distillation, membranes, or absorption, which can be physical or chemical. These technologies may be used to retrofit existing plants or incorporated into the design of new industrial facilities and electricity generating plants. There are some outstanding issues with these technologies that need to be addressed. One issue is the loss of efficiency. Energy is required to operate these technologies, thus lowering the overall power plant efficiency and increasing power generation costs. A second issue is the energy loss associated with the compression of the CO_2 after it is captured and prepared for pipeline transport. There are commercially available technologies that perform post-combustion capture, but generally, they have not been applied to large volumes of flue-gas streams such as those created by coal-fired power plants.

Pre-combustion capture first reacts the fuel with oxygen in a gasifier to create a syngas consisting of carbon monoxide and hydrogen—an Integrated Gasification Combined Cycle (IGCC) plant is currently a requirement for the pre-combustion capture of CO_2 for electricity generation. The syngas is cleaned of conventional pollutants (SO_2, particulates) and sent to a shift reactor which uses steam and a catalyst to produce CO_2 and hydrogen. Then, a physical solvent can be used to separate out the CO_2. After the capture process, the CO_2 can be compressed for transportation and long-term storage in geologic formations. The hydrogen is directed through gas and steam cycles to produce electricity. While construction costs for an IGCC plant are higher than those for a pulverized coal plant, IGCC's operate at a higher efficiency and the penalty for the carbon capture technology is considered to be less. There are currently two commercial IGCC plants operating in the United States, and despite the potential for improved environmental performance and greater fuel

[1] International Energy Agency, *World Energy Outlook 2007: China and India Insights,* p. 593.
[2] International Energy Agency, *Energy Technology Perspectives 2008: Scenarios & Strategies to 2050,* p. 52.
[3] OECD/IEA, *CO_2 Capture and Storage: A Key Carbon Abatement Option,* 2008, p. 46.

efficiency of IGCC, higher costs have held back a major breakthrough in the U.S. market.

The oxy-fuel process feeds pure oxygen into the combustion process of the conventional air-fired power plant. This type of technology aims to address CO_2 during the combustion stage by increasing the CO_2 concentration of the flue gas exiting the boiler so that less energy is required to prepare the gas for storage. A main advantage is that the lower the energy penalty, the lower the cost. However, the pure oxygen generally would be provided by an air-separation unit which is energy intensive to operate and a primary source of reduced efficiency. There is ongoing work targeted at improving the efficiency of this air-separation process. There are initiatives in the United States to demonstrate this type of technology, but it has not yet been tested in a large-scale facility.[4]

Carbon Storage

Following the compression and transportation (if needed) of the captured CO_2, it would be injected into suitable geological formations for long-term storage. Currently, the most promising reservoirs for storing CO_2 are oil and gas fields, deep saline reservoirs and unmineable coal seams. The geologic formations best suited to trap large volumes of CO_2 and do so without leakage would have characteristics that include open spaces or porosity, sufficient interconnectivity between the open spaces so that CO_2 can flow laterally or migrate within the formations (known as permeability) and a layer of cap rock that is impermeable to prevent the upward flow of CO_2 keeping it underground.

The Department of Energy has made an assessment of the potential sequestration capacity across the United States and parts of Canada and determined there exists sufficient volume to store approximately 600 years of CO_2 produced from total U.S. fossil fuel emissions at current rates. The accuracy of this CO_2 storage capacity estimate will be tested and updated as the Department's seven regional sequestration partnerships continue to conduct injection tests and carry out large-scale injection experiments. For example, the tests conducted by the partnerships will help to confirm the efficiency of the available pore space and evaluate their assumptions about the properties of the geologic formations.

Characterizing geologic reservoirs for the purposes of CO_2 sequestration is an ongoing research effort including the work done by the Department's sequestration partnerships. Information derived from ongoing research and demonstration efforts will provide information that would be used to guide site selection for full-scale CCS operations in the future. This is particularly important for non-oil and gas sites, such as deep saline reservoirs, which do not have the same level of engineering experience.

It is expected that the reservoir characterization process will rule out geologic formations that are risky because they are too shallow, inadequate caprock exists, or they are intersected by permeable faults and fractures and therefore provide pathways for CO_2 to escape. There are also concerns about the potential impacts of injected CO_2 on aquifers used for drinking water or as supplies for agriculture.

There are no federal regulations governing the injection and storage of CO_2 for the purposes of carbon sequestration. However, in July 2008, the U.S. Environmental Protection Agency released a draft rule that would regulate CO_2 injection for sequestration purposes under the authority of the *Safe Drinking Water Act,* Underground Injection Control (UIC) program. Final regulations are anticipated in the 2010/2011 timeframe.

The terms measurement, monitoring and verification (MMV) are frequently used to describe the plan and tools for characterizing the subsurface reservoir and for detecting changes throughout the injection, closure, and long-term oversight of a geologic storage project. Because the geology varies from site to site, there is no universal agreement on the specific elements that should be included in MMV for all large-scale geologic sequestration projects.

FutureGen:

In 2003, President Bush and the Department of Energy announced their FutureGen initiative. FutureGen was described as the first zero-emission, coal-fired electricity-generating plant that would also produce hydrogen. FutureGen was a major technology initiative to address climate change and to support the Administration's hydrogen fuel initiative.

[4] Department of Energy, *Strategies for the Commercialization and Deployment of Greenhouse Gas Intensity-Reducing Technologies and Practices,* January 2009.

Under the FutureGen program, DOE would oversee a consortium of industrial interests (the FutureGen Alliance) and international partners that would manage the construction of a $1 billion next-generation integrated gasification combined cycle (IGCC) power plant to produce electricity and hydrogen. There were three main components to the original FutureGen program. It would be a state-of-the-art demonstration of a 275 megawatt IGCC power plant designed to capture, compress and store carbon dioxide, emit virtually no conventional air pollutants, and produce hydrogen fuel. FutureGen was also intended as the United State's major collaborative effort with international partners (India, Korea, etc.) to demonstrate an integrated CCS system using advanced gasification technology. Finally, FutureGen was to serve as a living laboratory to test advanced coal technologies in order to achieve operational efficiencies and speed deployment of CCS technologies. Between FY 2003 and FY 2008, Congress appropriated approximately $174 million for the FutureGen Initiative.

On January 30, 2008, the Department of Energy announced a major restructuring of the FutureGen program. Rather than build a 275-megawatt IGCC power plant to test CCS technologies and provide for the demonstration of an integrated carbon capture and sequestration system, the Department would support the private sector's investment in IGCC power plants by providing the additional funding needed to add CCS technologies to the construction of multiple commercial power plants being pursued by industry. Although, initially the restructured FutureGen focused on IGCC facilities, the final Funding Opportunity Announcement included other advanced coal power plants. It is important to note, that the restructured program eliminates the hydrogen production and the living laboratory components of the original program.

Since the announcement to restructure FutureGen, DOE issued a Funding Opportunity Announcement for the restructured program in June 2008. The Department has received a handful of proposals and those proposals are under review. In addition, the *American Recovery and Reinvestment Act* (ARRA) of 2009 includes $3.4 billion for fossil energy research and development and some of these funds could be used for FutureGen. Recently, Secretary Chu testified in the Senate Energy and Natural Resources Committee that he would support the plant with "some modifications."[5] In response to the ARRA, DOE is planning to issue four Funding Opportunity Announcements for improving techniques to clean or capture and store the emissions from coal-fired electric generating plants and other industrial sources. It is still unclear if those funds will be used for FutureGen and what, if any, modifications will be made to the FutureGen program going forward.

International Activities:

China is the world's largest coal user, accounting for 63 percent of the country's total primary energy supply.[6] India is the world's third-largest coal user accounting for 62 percent of the country's energy supply and its use is expected to grow rapidly.[7] As stated above, the United States relies on coal for approximately 50 percent of its electricity production. Climate change is a global problem and major world economies see a growing need to work collaboratively to develop and deploy advanced coal technologies.

This past summer at the G–8 Summit in Japan, the G–8 leaders asked the International Energy Agency (IEA) to develop an energy roadmap for CCS technologies. The IEA intends to build the roadmap based on workshops convened in 2006–2007 by the IEA and the Carbon Sequestration Leadership Forum (CSLF). The roadmap will make recommendations for the G–8 in policy areas including financial, legal and international cooperation endeavors to help expand the deployment of CCS strategies. The G–8 Ministers also issued a joint-statement supporting the IEA and CSLF's recommendation to launch 20 large-scale CCS projects globally. Australia has taken steps to create a Global Carbon Capture and Storage Institute to assess CCS and facilitate international research collaboration covering a range of technologies and geologies. The European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP) was founded in 2005 to ensure CCS is commercialized by 2020. In 2004, the China Huaneng Group led the development of the GreenGen project to build an IGCC plant with CCS. While pieces of an integrated CCS system are being demonstrated at various scales throughout the world, no large-scale inte-

[5] Kindy, Kimberly, "New Life for 'Clean Coal' Project: Illinois Plant was Abandoned by Bush, Now Its Backers are in Power," *Washington Post,* Friday, March 6, 2009.

[6] OECD/International Energy Agency, *CO_2 Capture and Storage: A Key Carbon Abatement Option,"* 2008, p. 154.

[7] OECD/International Energy Agency, *CO_2 Capture and Storage: A Key Carbon Abatement Option,"* 2008, p. 162.

grated CCS project has been conducted on a coal-fired power plant to date. Knowledge transfer of these technologies and investment cooperation may be critical if international goals for greenhouse gas emissions reductions are to be achieved.

Chair BAIRD. Good morning, everyone and thank you for being here. Our hearing will now come to order. I want to welcome everybody to the Energy and Environment Subcommittee's hearing on *"FutureGen and the Department of Energy's Advanced Coal Programs."* I would like to thank our expert panel of witnesses for being here today, and I look forward to your testimony about the potential role advanced coal technologies, including carbon capture and storage, may play in helping to solve the daunting challenge of climate change and ocean acidification.

We burn a lot of coal in this country and around the world. The United States is one of the largest consumers of coal, and this is one of the major reasons we are one of the largest emitters of ocean acidification and overheated gases. But we are not the only country with strong dependence on coal. China and India have both expanded their coal use. I was in China just a couple of years ago and was told they are putting on coal-powered plants every couple of weeks, gradually comes on line. It is astonishing, really. In 2007 China surpassed us to become the largest contributor to global CO_2 emissions. I do not say this to point fingers, but to point out that overheating and ocean acidification truly are a global problem, and we must work with other developed nations and developing economies to find solutions to those staggering challenges.

I think the United States should take the lead in reducing energy consumption and particularly consumption of fossil fuels. We have a variety of tools at our disposal to accomplish that goal. We can develop and deploy advanced, green technologies, adopt better conservation practices and energy efficiency policies, and as individuals, we can behave more responsibly. Without bold policies and public and personal commitment, we run the risk of serious damage to our environment and our society. That outcome is simply unacceptable.

If 41 percent of our global electricity supply comes from burning coal, then it is imperative that we curtail the gas emissions from this major source. We must act now to do so. I recognize that approximately 50 percent of the power supply in the United States comes from coal-fired plants, so we can't expect to tackle this challenge overnight. But it is my sincere hope and expectation that we can devise a strategy forward that achieves the remarkable reduction in greenhouse gaseous emissions in a safe, responsible and sustainable manner.

Today's hearing provides us with an excellent opportunity to discuss our overall strategy to reduce emissions from large stationary sources, such as electric generation plants. I think there are some lessons we can learn from the decisions about the FutureGen program, and I am hopeful that we can have a very honest conversation today about the near-term and long-term objectives and challenges for the Department of Energy's advanced coal programs.

Finally, I am pleased that this hearing will include an important dialogue about international collaboration on strategies for implementing carbon capture and sequestration. As I said, global overheating and ocean acidification is a global problem and it requires a global solution.

Again, I thank the panel for being here this morning and I look forward to your testimony and an interesting discussion.

With that, I recognize Mr. Inglis for an opening statement.
[The prepared statement of Chair Baird follows:]

PREPARED STATEMENT OF CHAIR BRIAN BAIRD

Good morning. I would like to welcome everybody to the Energy and Environment Subcommittee's hearing on *"FutureGen and the Department of Energy's Advanced Coal Programs."* I would like to thank our expert panel of witnesses for being here today and I look forward to your testimony about the potential role advanced coal technologies, including carbon capture and storage, may play in helping to solve the daunting challenge of climate change and ocean acidification.

We burn a lot of coal in this country and around the world. The United States is one of the largest consumers of coal and this is one of the major reasons we are one of the largest emitters of greenhouse gases. But we are not the only country with strong dependence on coal. China and India have both expanded their coal use, and in 2007 China surpassed us to become the largest contributor to global CO_2 emissions. I do not say this to point fingers, but to point out that climate change truly is a global problem, and we must work with other developed nations and developing economies to find solutions to this staggering problem.

I think the United States should take the lead in reducing energy consumption and particularly consumption of fossil fuels. We have a variety of tools at our disposal to accomplish that goal. We can develop and deploy advanced, green technologies, adopt better conservation practices and energy efficiency policies, and as individuals, behave more responsibly. Without bold policies and public and personal commitment, we run the risk of serious damage to our environment and our society. That outcome is simply unacceptable.

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Finally, I am pleased that this hearing will include an important dialogue about international collaboration on strategies for implementing carbon capture and sequestration systems. As I said, climate change is a global problem and it requires a global solution.

Again, I thank the panel for being here this morning and I look forward to your testimony and an interesting discussion.

Mr. INGLIS. Thank you, Mr. Chairman. Thank you for holding this hearing. You know, in South Carolina we have a case study of one of the cases with respect to coal, and that is that Duke Energy would like to build a nuclear power plant or two but the question is whether you can do that effectively or whether it is really just easier and cheaper to build coal plants. We are not so dependent on the jobs associated with coal. There are some parts of our country that are, but we are the users, we are the people that burn coal because it is a pretty cheap way to make electricity, especially if you have no accountability for what is coming out of the smokestack. And so the question, then, is whether something can be done to clean up that coal to—we have had a number of hearings in this committee about sequestration, that sort of thing, because we know we can burn it cleanly, and General Electric has a number of proven models that show that you can basically separate out the hydrogen and burn that, and that is pretty exciting. Still, you have still got the CO_2 issue.

So the question is whether we can figure out a way to really improve that process or have some sort of breakthrough that would make it possible to continue that employment in some places in the country that are dependent on coal and somehow control the CO_2 problem.

That is certainly our hope in this FutureGen program, and so we look forward to hearing from the witnesses about what the future may be. And it is interesting to note that folks like Duke Engineering are not alone. We use lots of coal, and figuring out ways to make it cleaner and to collect up the CO_2 would be an incredible breakthrough.

So we look forward to hearing from the witnesses, Mr. Chairman, and hope that there is some way to break through to truly clean coal. Thank you, Mr. Chairman.

[The prepared statement of Mr. Inglis follows:]

PREPARED STATEMENT OF REPRESENTATIVE BOB INGLIS

Thank you for holding this hearing, Mr. Chairman.

Duke Energy faces a dilemma in South Carolina. They would like to produce energy free of CO_2 emissions and help bring the energy solutions of tomorrow to their customers today. The licensing and cost hurdles of nuclear, wind, and solar power have forced Duke instead to meet increased energy demand by building coal-powered plants.

Duke Energy is not alone. We're using lots of coal. We need to focus on ways to make that consumption cleaner and more efficient. Perhaps if we had clean coal and carbon capture technologies readily available and affordable, companies like Duke would be able to meet growing energy demand with coal and without emissions.

We need these technologies to be affordable and attractive to U.S. and global industry alike. America can lead the way with technological innovation that can be easily integrated into existing coal plants worldwide.

The Department of Energy's decision to restructure the FutureGen program in 2008 compromised some important components of clean coal research. We had hoped for the production and capture of hydrogen fuel. We had hoped for a laboratory to test new technologies. I'm interested in hearing how DOE plans to reevaluate the role of the FutureGen program in meeting our clean coal and carbon capture and sequestration objectives.

But with or without FutureGen, Congress is aggressively seeking an answer to our carbon emissions problem. I believe the best way to do this is to attach a straightforward price to carbon emissions and reduce payroll taxes in an equal and offsetting amount. By forcing the market to internalize the externals associated with burning fossil fuels, we can encourage cutting edge innovation in energy technologies and help America be a leader in finding the energy solutions of tomorrow.

Thank you again for holding this hearing, Mr. Chairman, and I look forward to hearing from our witnesses.

Chair BAIRD. I would like to at this point recognize the gentleman, Mr. Costello, who has been a very, very influential and interested party on this issue, and Mr. Costello, we welcome your remarks.

Mr. COSTELLO. Mr. Chairman, thank you. And I have a statement that I will enter into the record and make some brief comments concerning the GAO report and the purpose of this hearing. But first, let me not only thank you for recognizing me but also for calling this hearing today, and thank you as well for joining Chairman Gordon and Mr. Lipinski and I in requesting this GAO report.

As you noted, I guess it has been over five years now that I have been involved with this project, and in fact as I think everyone knows that over one half of our electricity is generated from coal. Coal is the cheapest form of electricity generation, and we have coal reserves just in my home State of Illinois alone that contains more BTU's than oil reserves in Saudi Arabia and Kuwait.

Like everyone, I want our nation's energy policy to help reduce carbon emissions and to address the climate change issue that we are all facing, but in order to meet these goals, our dependence on coal requires significant investment in clean technologies to burn coal as efficiently and as cleanly as possible. The reality is that our dependence on coal as an energy source is not going away any time soon, and as you noted in your opening statement, we are not the only nation that is reliant on coal as an energy source. China, as you said, they are actually constructing one coal-fired plant every week now in China. When we develop clean-coal technology here in this country, countries like China, India and other countries will in fact hopefully use that technology to achieve our goal.

I want to say that when the President announced in the State of the Union Address in 2003, President Bush, this was his initiative, the FutureGen project. I was excited about it to the extent that after listening to the State of the Union Address, the next morning I picked up the telephone and called the Secretary of Energy and said I am a supporter of this project. I want to move forward. We want to do everything we can to help move the project forward. So you can imagine how disappointed I was, not only disappointed but outraged, after five and a half years of research and spending literally tens of millions of dollars on this project, that the Department of Energy and the Administration decided to pull the plug on the project.

We in this subcommittee heard testimony from the representatives from the Department of Energy as to why the decision was made. They said basically that the reason that the project was going to be pulled and reassessed and realigned was because of cost, the escalating cost. We questioned that at the time and, you know, obviously today, with the GAO findings and we will get into that and there are some quotes that I will put into the record very shortly, it was not cost. I said here sitting in this subcommittee room that I believed at the time that it was based on politics, that we had four sites that were the finalists, two in Texas and two in the State of Illinois, and when the alliance, the independent alliance that was appointed not only for their expertise on this issue but also to remove politics and to have independence from a political decision but to base decisions on the science and what was best for the country, they examined all four sites and came up with the site in Mattoon, Illinois, and said that the Mattoon site was the best site, and it was then that the Administration decided, well, we are going to pull back on the project and pull the plug. So we know today that the GAO report says that it was not based upon costs, and of course, they don't go into what the decision was based on, but I think that through the process of elimination, we know what it was based on.

My goal is to get the project back on track. My goal is to not only move FutureGen and sequestration forward but also to look at other clean-coal technologies so that we in fact can begin to burn coal as cleanly and efficiently as possible.

So Mr. Chairman, again, I thank you for calling the hearing today. I look forward to hearing the testimony of our witnesses and look forward to moving this project forward.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Thank you, Mr. Chairman, for calling today's hearing on the FutureGen project. The FutureGen project has been one that I have worked on very closely over the past five and a half years and I am interested in hearing from GAO and our other witnesses on this issue.

Mr. Chairman, we generate over one-half of our electricity from coal and the coal reserves in my home State of Illinois contain more Btu's than the oil reserves of Saudi Arabia and Kuwait. Like many, I want our nation's energy policy to help reduce carbon emissions and adequately address the real concerns of climate change. In order to meet these goals, our dependence on coal requires a significant investment in clean technologies to reliably burn coal as efficiently and as cleanly as possible. The reality is that our dependence on coal as an energy source is not going away. We are not alone in our reliance on this energy source; to satisfy its rapidly growing population and economy, China is adding one new coal-fired plant to its power grid each week.

For these reasons, the day after the President announced the FutureGen Clean Coal Initiative in his 2003 State of the Union address, I was on the phone with the Department of Energy (DOE), working to get the project off the ground. After five years of work with DOE, with the FutureGen Alliance, the State of Illinois and others, I was extremely disappointed that DOE decided to scrap the project in favor of a "re-scoped" plan. I was pleased to join Chairman Gordon, Chairman Baird, and Mr. Lipinski in requesting GAO to further examine the reasoning behind the decision to abandon the original project.

I have stated previously during Science Committee hearings that I did not find DOE's justifications for canceling FutureGen to be based on accurate information or factual analysis. GAO's final report affirms what we thought from the beginning: to quote directly from the report, "DOE did not base its decision to restructure FutureGen on a comprehensive analysis of factors, such as the associated costs, benefits and risks . . . [consequently] DOE has no assurance that the restructured FutureGen is the best option to advance CCS."

As a supporter of clean coal technology, I am focused on getting this project back on track. DOE's decision has already meant wasted time, and has delayed the project for over a year at a time when the need for public investment in clean, efficient energy technologies could not be more evident. Despite DOE's decision to back away from its agreement with the FutureGen Alliance, an international non-profit consortium of some of the largest coal producers and users in the world, the group did not dissolve, but in fact continued its commitment to the project by purchasing the land for the plant in Mattoon, Illinois. With the legal and environmental issues surrounding this project already resolved and its investors still committed, FutureGen is as shovel-ready as any other clean coal project in the country. It is my hope that with new leadership and new analysis, the FutureGen project can realize its full potential to become world's first coal-fueled, near-zero emissions power plant.

Thank you, Mr. Chairman, and I look forward to hearing from our distinguished panel of witnesses.

Chair BAIRD. I thank you, Mr. Costello, and thanks for your leadership on this very issue for so many years now.

If there are other Members who wish to submit opening statements, your statement will be added to the record at this point.

And now I would like to introduce our witnesses. Our first witness is Dr. Victor Der. Dr. Der is the Acting Assistant Secretary for the Department of Energy's Office of Fossil Energy. I want to briefly note, Dr. Der, I appreciate very much your work with a company in Washington State that has developed leading-edge technology on compression of gases which will be absolutely essential to success at some point if we move forward with this, and it is always nice when you hear from local constituents who say they have worked well with a government entity that has been very, very helpful, and thank you for your work on that.

Mr. Mark Gaffigan is the Director of the Natural Resources and Environment Team at the U.S. Government Accountability Office involved in preparing some of the reports that Mr. Costello alluded to. Dr. Robert Finley is the Director of the Energy and Earth Resources Center at the Illinois State Geological Survey. Dr. Finley, thank you for being here. Mr. Larry Monroe is the Senior Research Consultant at Southern Company, and Ms. Sarah Forbes is the Senior Associate of the Climate and Energy Program at the World Resource Institute.

As our witnesses all know, you will have five minutes for your spoken testimony, then written testimony will be included in the record for the hearing. When each of you has concluded your combined testimony, we will have testimony from the panel. This is a bipartisan, friendly committee that asks tough questions, but in the way of trying to understand difficult and challenging issues. And with that, let us start with Dr. Der.

STATEMENT OF DR. VICTOR K. DER, ACTING ASSISTANT SECRETARY, OFFICE OF FOSSIL ENERGY, U.S. DEPARTMENT OF ENERGY

Dr. DER. Thank you, Mr. Chairman. I appreciate this opportunity to discuss the Department of Energy's advanced coal program with the keen focus on safe, effective and affordable carbon capture and storage.

Coal represents a tremendous and strategic national asset with enough supply to take us well into the next century based on the current rates of consumption, and as we explore energy alternatives, coal used in environmentally sustainable and responsible ways will continue to play a critical role in the Nation's energy strategy. Our focus must be, therefore, to develop deployable advanced technologies necessary to achieve near-zero emissions from coal use, including carbon capture and storage, or CCS, not just in the United States, but in developing economies such as China and India which will continue to rely on coal. Thus, CCS is an essential component of the global greenhouse gas mitigation strategy.

DOE remains a leader in the development of advanced technologies that have helped reduce pollutant emissions and have increased power plan efficiency. These technological successes form a solid foundation upon which to build advances and innovations needed to meet the challenges of CO_2 reductions.

The advanced coal program is geared toward developing a portfolio of revolutionary technologies for CCS. To that end, and in partnership with the private sector, the program is focused on three important areas: technologies for affordable CO_2 capture, especially back-end stack capture; establishing the scientific and technical basis for safe and effective storage of CO_2; and substantially improving the efficiency and reliability of fossil energy systems. All three of these areas are important as we work to make CCS technologies deployable and cost effective.

We have a good start in this direction based on years of research and demonstration experience that have resulted in new concepts, including the conversion of coal into cleaner, versatile gases that can be used to generate power or produce fuels. Additionally, our research continues to explore emerging approaches to clean power generation that hold great promise for integration with coal-based or combined coal and biomass energy plants with CCS. To this end, we are working on CCS enabling and transformational technologies, including advanced integrated gasification combined cycle, advanced hydrogen turbines, advanced materials for ultra high-efficiency plants, supersonic compression, and revolutionary concepts for CO_2 capture.

The success of our programs will ultimately be judged by the extent to which emerging and cost-effective technologies are deployed domestically and internationally. That is why DOE is implementing large large-scale CCS demonstration efforts under the sequestration partnerships and the clean coal power initiative programs. And that is why we have taken a lead role in global partnerships like the Carbon Sequestration Leadership Forum, the Asia Pacific Economic Cooperation, the International Energy Agency, and bilateral collaboration with countries such as Canada, India, and China and other international initiatives.

Mr. Chairman, today nearly 75 percent of the coal power plants in the United States employ technologies with roots in DOE's program for advanced coal. With continued leadership and support from the Administration and Congress, we can accelerate the development of new technologies to meet the requirements of a safe and secure energy future while reducing our carbon footprint.

Again, Mr. Chairman, thank you for the opportunity to testify here today, and with that, I will welcome any questions that the Committee may have.

[The prepared statement of Dr. Der follows:]

PREPARED STATEMENT OF VICTOR K. DER

Thank you, Mr. Chairman and Members of the Committee. I appreciate this opportunity to provide testimony on the U.S. Department of Energy's (DOE's) advanced coal research, development, and demonstration program to develop low-carbon emission coal technologies.

INTRODUCTION

Fossil fuel resources represent a tremendous national asset. An abundance of fossil fuels in North America has contributed to our nation's economic prosperity. Based upon current rates of consumption, the United States probably has sufficient coal to meet its need for the next century. Making use of this domestic asset in a responsible manner will help the United States to meet its energy requirements, minimize detrimental environmental impacts, positively contribute to national security, and compete in the global marketplace.

Fossil fuels will play a critical role in our nation's future energy strategy. By developing technologies to mitigate the release of carbon dioxide (CO_2) into the atmosphere, we can continue to use our extensive domestic coal resource while reducing the impacts on climate viable energy source for our nation. CCS is the primary pathway DOE is pursuing to allow continued use of fossil fuels in a carbon-constrained future.

Through fossil energy provisions in the *American Recovery and Reinvestment Act* and annual appropriations, DOE's advanced coal program is working to accelerate the development of CCS to meet future energy needs.

The remainder of my testimony will highlight CCS activities that are underway in the advanced coal program.

NEAR-ZERO EMISSIONS PROGRAM

DOE provides a national leadership role in the development of advanced coal technologies. DOE's advanced coal program has returned substantial benefits to consumers and taxpayers across a broad range of innovative technologies that are now in use throughout the world. For example, DOE and the private sector responded to the challenge of dramatically reducing the emissions of particulate, sulfur, nitrogen oxide, and mercury from coal-based energy systems with the development of technologies that enable coal-based power plants to meet environmental controls and limits placed on these pollutants. These technological innovations have resulted in significant environmental benefits: reducing pollutant emissions, reducing water use, minimizing wastewater discharge, and reducing solid wastes. DOE research and demonstration capabilities are well suited to address new challenges associated with the reduction of greenhouse gas emissions as a climate change mitigation strategy.

The advanced coal program—administered by DOE's Office of Fossil Energy and implemented by the National Energy Technology Laboratory—is designed to address climate concerns of coal usage by developing a portfolio of revolutionary advanced carbon capture and efficiency and performance, while minimizing the costs of these new technologies. In recent years, the Program has been restructured to focus on CCS. The Program pursues the following two major strategies:

1) capturing carbon dioxide; and
2) storing it in geologic formations.

Capturing and storing carbon dioxide and improving the fuel-to-energy efficiency of CCS will help address pollutant emissions reduction, water usage, and carbon emissions on a per unit of electricity basis. These plans strive to achieve dramatic reductions in emissions and ensure that current and future fossil energy plants will meet all emerging requirements for a safe and secure energy future.

Coal research has resulted in important insights regarding future innovations. New engineering concepts have been developed to convert coal into gases that can be cleaned and then used to generate power or produce fuels. New approaches to clean power generation are emerging that hold promise for integration with coal-based or combined coal and biomass energy plants. Technologies for achieving CCS are stretching beyond basic research, defining pathways in which greenhouse gas emissions can be permanently diverted from the atmosphere. With these building blocks, a new breed of coal plant can be created—one that generates power and produces high-value energy with much less environmental impact. DOE's work includes a focus on high priority CCS enabling technologies, such as advanced integrated gasification combined cycle, advanced hydrogen turbines, carbon capture, and fuel cells. These research areas provide the supporting technology base for all CCS development.

As part of our advanced coal program, we are addressing the key technology challenges that confront the wide-scale deployment of CCS through research on cost-effective capture technologies; monitoring, verification, and accounting technologies to ensure permanent storage; permitting issues; liability issues; public outreach; and infrastructure needs. As an example, today's commercially available CCS technologies will add around 80 percent to the cost of electricity for a new pulverized coal plant, and around 35 percent to the cost of electricity for a new advanced gasification-based plant.[1] The program is aggressively pursuing developments to reduce these costs to less than a 10 percent increase in the cost of electricity for new gasification-based energy plants, and less than a 30 percent increase in the cost of electricity for pulverized coal energy plants.[2]

The existing research program has been performing CCS field tests for many years, where the Regional Carbon Sequestration Partnerships are drilling wells in potential storage locations and injecting small quantities of CO_2 to validate the potential of key storage locations throughout the country. Substantial progress has occurred in the area of monitoring, verification, and accounting of CO_2 storage with the development and refinement of technologies to better understand storage stability, permanence, and the characteristics of CO_2 migration.

Research is also focused on developing technology options that dramatically lower the cost of capturing CO_2 from fossil fuel energy plants. This research can be categorized into three pathways: post-combustion, pre-combustion, and oxy-combustion. Post-combustion refers to capturing CO_2 from the stack gas after a fuel has been combusted in air. Pre-combustion refers to a process where a hydrocarbon fuel is gasified to form a synthetic mixture of hydrogen and carbon dioxide, and CO_2 is captured from the synthesis gas before it is combusted. Oxy-combustion is an approach

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[1] *Cost and Performance Baseline for Fossil Energy Plants, Volume 1: Bituminous Coal and Natural Gas to Electricity,* U.S. Department of Energy/National Energy Technology Laboratory, DOE/NETL–2007/1281, Final Report, May 2007.
[2] The goal for pulverized coal is under development.

where a hydrocarbon fuel is combusted in pure or nearly pure oxygen rather than air, which produces a mixture of CO_2 and water that can easily be separated to produce pure CO_2. This research is exploring a wide range of approaches: membranes; oxy-combustion concepts; solid sorbents; CO_2 hydrates; and advanced gas/liquid scrubbing technologies. These efforts cover not only improvements to state-of-the-art technologies but also development of several revolutionary concepts, such as metal organic frameworks, ionic liquids, and enzyme-based systems, in conjunction with basic research in these areas now being conducted by the DOE's Office of Science.

A central piece of our CCS research is DOE's field test program, which is being implemented through the Regional Carbon Sequestration Partnerships. DOE's field test program reflects the geographic differences in fossil fuel use and potential storage sites across the United States and targets the use of regional approaches in addressing CCS. It encompasses approximately 97 percent of coal-fired and industrial CO_2 emissions, about 96 percent of the total land mass, and essentially all the geologic storage sites in the country that can potentially be available for carbon sequestration. The field tests are conducted through partnerships comprised of State agencies, universities, and private companies, with the goal of developing the knowledge base and infrastructure for the wide-scale deployment of CCS technologies. The seven Regional Partnerships represent more than 350 unique organizations in forty-two States, three Indian Nations, and four Canadian Provinces. It is important to note that the non-federal cost share for the field test program is greater than 35 percent, which is a key indicator of industry and other partner interest the country with similar characteristics relating to CCS opportunities.

DOE is addressing key infrastructure issues related to permitting, pore space ownership, site access, liability, public outreach, and education. DOE works closely with the Environmental Protection Agency (EPA) and others in developing CCS regulation strategies, which will provide additional certainty for future CCS deployments.

Over the course of these research initiatives, DOE will jointly develop Best Practice Manuals on topics such as site characterization, site construction, operations, monitoring, mitigation, closure, and long-term stewardship. These Manuals, which will be developed in conjunction with DOE's Office of Science and the U.S. Geological Survey, will serve as guidelines for a future geologic sequestration industry in their regions, and help transfer the lessons to all regional stakeholders.

LARGE-SCALE DEMONSTRATION AT COMMERCIAL SCALE

The success of our research on CCS and advanced coal technologies will ultimately be judged by the extent to which emerging technologies are deployed in domestic and international marketplaces. Both technical and financial challenges associated with the deployment of new integrated CCS technologies must be overcome in order to be capable of achieving success in the marketplace. Commercial-scale demonstrations help the industry understand and overcome start-up issues, component integration issues, and gain the early learning commercial experience necessary to reduce risk and secure private financing and investment for future plants.

DOE is implementing large-scale programs such as the geologic storage field tests and the Clean Coal Power Initiative (CCPI). Phase III of the geologic storage field test program is focused on large-scale field tests of geologic carbon sequestration on the order of one million infrastructure needs of these projects. CCPI is primarily focused on component testing at commercial scale. The CCPI Round 3 Funding Opportunity Announcement (FOA) specifically targets advanced coal-based systems and subsystems that capture or separate CO_2 for sequestration or for beneficial use.

THE AMERICAN RECOVERY AND REINVESTMENT ACT

The *American Recovery and Reinvestment Act* (Recovery Act) appropriates $3,400,000,000 for "Fossil Energy Research and Development." As reflected in the Joint Explanatory Statement of the Committee of Conference leading to the Act, these Recovery Act funds will help fund activities targeted at expanding and accelerating the commercial deployment of CCS technology to provide a key thrust to the advanced coal program to accelerate, by many years, the advances needed for future plants with CCS.

The Joint Explanatory Statement of the Recovery Act identifies the following major initiatives that will complement and accelerate efforts in the advanced coal program:

Maintain Fossil Energy R&D Program: $1 billion to be used to conduct fossil energy research and development.

Additional Funds for the CCPI Round 3 FOA: $800 million to be used to augment funding for the CCPI Round 3 competition.

New CCS Initiative for Industrial Applications: $1.52 billion to be used for a competitive solicitation for a range of industrial carbon capture and energy efficiency improvement projects, including a small allocation for innovative concepts for beneficial CO_2 reuse.

Expand Geologic Site Characterization: $50 million to be used for site characterization activities in geologic formations. DOE expects to require projects to complement and build upon the existing characterization base created by the Regional Partnerships, looking at broadening the range and extent of geologic basins that have been studied to date.

Initiate a Geologic Sequestration Training and Research Grant Program: $20 million for geologic sequestration training and research grants. This program will emphasize advancing educational opportunities across a broad range of colleges and universities.

INTERNATIONAL COLLABORATIONS

Recognizing that climate change is a global issue that requires a global response, the DOE plays an active leadership role in an international initiative known as the Carbon Sequestration Leadership Forum (CSLF).

The CSLF is a voluntary climate initiative of developed and developing nations that, collectively, account for 75 percent of all manmade carbon dioxide emissions. It is currently comprised of 22 members, including 21 countries and the European Commission.

Formed in 2003, the CSLF marshals intellectual, technical, and financial resources from all parts of the world to support atmospheric stabilization, the long-term goal of the United Nations Framework Convention on Climate Change. Members are dedicated to collaboration and information sharing in developing, demonstrating, and fostering the worldwide deployment of multiple technologies for the capture and long-term geologic storage of carbon dioxide at low costs. Additionally, the CSLF is committed to establishing a companion foundation promoting legislative, regulatory, administrative, and institutional practices that will ensure safe, verifiable long-term storage.

numerous countries through bilateral agreements and multilateral activities to identify areas of collaboration in promoting and developing clean fossil energy technologies internationally.

These activities include:

The U.S.-China Fossil Energy Protocol, a bilateral agreement on energy technology cooperation that has the goals of reducing the impact of China's growing demands on global hydrocarbon markets and improving environmental performance; providing commercial opportunities for U.S. business; and acquiring unique information of scientific or technical interest to DOE.

U.S.-India Energy Dialogue: Coal Working Group: The Office of Fossil Energy and India's Ministry of Coal jointly chair the Coal Working Group initiative to exchange information on policies, programs, and technologies to promote the efficient and environmentally responsible production and use of coal.

Global Gas Flaring Reduction Partnership: DOE is working with the World Bank and others to support national governments and the petroleum industry in their efforts to reduce flaring and venting of gas associated with the extraction of crude oil. Gas flaring wastes a valuable clean energy resource and emits carbon dioxide, a greenhouse gas.

Asia Pacific Economic Cooperation: APEC's Energy Working Group seeks to maximize the energy sector's contribution to the region's economic and social well being, while mitigating the environmental effects of energy supply and use. The Office of Fossil Energy provides expertise in LNG and methane hydrate technologies to the Energy Working Group.

The International Energy Agency (IEA): The Office of Fossil Energy is involved in many aspects of the IEA, including emergency preparedness and clean coal technology transfer. Increasingly, the IEA focuses on resolving energy and environmental challenges, particularly relating to climate change.

The Office of Fossil Energy participates in the IEA Working Party on Fossil Fuels, a highly effective method to create international support for Fossil Energy programs and objectives such as IGCC and carbon sequestration. The primary objective for the next three years will be to develop and implement activities to promote clean fossil energy technologies internationally. The Office of Fossil Energy is currently working on the implementation of the recommendations to the G–8 on Near-Term Opportunities for Carbon Capture and Storage.

IEA Clean Coal Center: The IEA Clean Coal Centre is a collaborative project established in 1975 involving member countries of the IEA. The service is governed by representatives of member countries, the European Commission, and industrial sponsors. The IEA Clean Coal Centre program of work contains studies of considerable significance for all countries involved in the use or supply of coal.

IEA Greenhouse Gas Program (IEAGHG): The IEAGHG is a collaborative research program founded in 1991. The members include 17 countries, the European Commission and 17 multinational industrial sponsors. Its aim is to provide members with definitive information on the role that technology can play in reducing greenhouse gas emissions. It is principally focused on CCS; how mitigation options compare; how CCS can be done safely, legally, and cost-effectively; and what needs to be done to introduce CCS and be confident it will be successful.

World Energy Council: World Energy Council (WEC) is an organization of more than 100 countries headquartered in London covering all aspects of energy including fossil, nuclear, hydro and renewables. DOE participates through the WEC Committee on Cleaner Fossil Fuel Systems Committee, chaired by the Fossil Energy's Office of Clean Energy Collaboration. Committee members include 26 countries and seven multilateral organizations striving to promote knowledge worldwide on the research, development, demonstration, and deployment of cleaner fossil fuels to meet global energy needs; promote the clean and efficient use of fossil fuels, with a concentration on carbon capture and storage.

Additionally, numerous international projects are supported through DOE's core advanced coal program. U.S. technological advances and expertise in CCS are being shared in initiatives such as the Australian Otway Basin project; the European Union funded CO_2SINK project in Germany; the Algerian In Salah industrial-scale CO_2 storage project; the Ordos Basin Assessment in China; the North Sea Sleipner Project; and the IEA GHG Weyburn-Midale CO_2 Monitoring and Storage Project, Zama Acid Gas Project, and the Fort Nelson Project, all in Canada.

CONCLUSIONS

Today, nearly three out of every four coal-burning power plants in this country are equipped with technologies that can trace their roots back to the Department's advanced coal technology program. These efforts helped accelerate production of cost-effective compliance options to address legacy environmental issues associated with coal use. Advanced CCS technologies will undoubtedly play a key role in mitigating CO_2 emissions under potential future carbon stabilization scenarios. DOE's Program is helping make the enabling technologies available. The United States must continue to show leadership in technology development and future deployment to bring economic rewards and new business opportunities both here and abroad.

I applaud the efforts of this committee and its Members for taking a leadership role in addressing these timely and significant issues.

BIOGRAPHY FOR VICTOR K. DER

Dr. Der is currently Principal Deputy Assistant Secretary for Fossil Energy with responsibilities for the office operations, and in support of the Assistant Secretary, he manages the oversight of Fossil Energy's Research and Development (encompassing coal, oil, and natural gas) program and the U.S. Petroleum Reserves. Prior that he was Deputy Assistant Secretary for Clean Coal within the Fossil Energy Program Office. In that capacity, he was responsible for directing research and development of clean coal research, development and demonstration, and implementation of energy policy initiatives and priorities relating to clean coal utilization and its role in climate change mitigation including carbon capture and sequestration.

Prior to that position, he was Director, Office of Clean Energy Systems for central power systems technologies such as gasification, advanced combustion and hydrogen turbines; distributed generation technologies such as fuel cells, fuel cell/turbine hybrids, and novel heat engines and compressors; emissions controls technologies; advanced research, and high efficiency, zero-emissions fossil energy technologies. He was also responsible for directing the large scale demonstration programs such as the Clean Coal Technology Demonstration program; the Power Plant Improvement Initiative; Clean Coal Power Initiative; and FutureGen—a demonstration program for near-zero emissions coal, including carbon emissions.

Dr. Der has worked at DOE for 35 years in various programs. He entered government service as a reactor intern in the predecessor agencies to DOE, starting with Atomic Energy Commission. He worked as a structural and materials engineer in nuclear reactor plant designs of the Fast Flux Test Facility and the Clinch River Breeder Reactor Demonstration during the Energy Research and Development Administration. Following this period he managed research in the civilian radioactive waste management program on geologic storage of high-level nuclear waste; superconductivity in the Office of Science's (formerly the Office of Energy Research) magnetic fusion energy program; and Fossil Energy's advanced coal and gas based power systems program.

His prior work includes NASA's Apollo 15 moon mission project and the National Oceanic and Atmospheric Administration program on modeling the upper atmospheric density.

His education includes a Bachelor of Science, Master of Science, and Ph.D. in Mechanical Engineering from the University of Maryland. He is married, has two daughters and resides in Gaithersburg, Maryland.

Chair BAIRD. Thank you Dr. Der. Mr. Gaffigan.

STATEMENT OF MR. MARK GAFFIGAN, DIRECTOR, NATURAL RESOURCES AND ENVIRONMENT TEAM, U.S. GOVERNMENT ACCOUNTABILITY OFFICE

Mr. GAFFIGAN. Chairman Baird, Ranking Member Inglis, Members of the Subcommittee, good morning. I am pleased to be with you to discuss GAO's recent report on the Department of Energy's decision to restructure the FutureGen program. In 2003, DOE initiated FutureGen, a program to design, build and operate a new coal-fired power plant that combined integrated gasification combined cycle or IGCC technology with carbon capture and storage.

However, in 2008, DOE announced that it had decided to restructure FutureGen. GAO's report and the focus of my remarks address three questions regarding restructured FutureGen. One, how do the goals of the proposed restructured FutureGen program compare to the original program? Two, how does restructured FutureGen compare to DOE's other carbon capture in-storage programs? And three, to what extent did DOE use sufficient information in its decision to restructure FutureGen?

First, restructured FutureGen is very different from the from the original FutureGen program. While Restructured FutureGen shares a common name and the overall goal of carbon capture and storage, it is fundamentally different from the original FutureGen program. Most significantly, the restructured program does not have an exclusive focus on the integration of integrated gasification combined cycle technology with carbon capture and storage. In addition, the restructured program does not have international partnerships that, in the original FutureGen program, were designed to improve the global advancing of carbon capture and storage.

Finally, restructured FutureGen unlike the original FutureGen is not designed to serve as a living laboratory host facility for gaining broad industry acceptance of emerging technologies. It moves from a research and development focus to a commercial focus.

In comparison to DOE's other carbon capture and storage programs, restructured FutureGen is most like round three of the Clean Coal-Powered Initiative. Most notably, both programs fund the commercial demonstration of carbon capture and storage at coal-fired power plants and require industry participants to bear at least 50 percent of the cost. Questions have been raised about how

Restructured FutureGen is different and the basis for the decision to restructure.

In short, DOE's decision to restructure FutureGen was not well-explained. DOE based its decision largely on its conclusion that cost for the original FutureGen had doubled and would escalate substantially. However, this conclusion is problematic because it was derived from a comparison of two cost estimates for the original FutureGen that were not comparable. It compared an initial estimate of approximately $950 million that was in constant dollars to a $1.8 billion that was inflated through the year 2017. The focus on the difference in these very preliminary cost estimates as the reason to restructure FutureGen did not provide a sound basis for the decision.

In contrast, DOE's Office of Fossil Energy had identified and analyzed other options for incremental cost-saving changes to the original program such as reducing the CO_2 capture requirement. However, we could not identify any comparable analysis that supported the decision to restructure FutureGen.

By integrating IGCC and carbon capture and storage technology, DOE's original FutureGen program was intended to address significant technological, cost, and regulatory issues associated with the implementation of carbon capture and storage at the new plant. Alternatively the restructured program leaves open the possibility of successfully applying carbon capture and storage technology to existing conventional pulverized coal-fired power plants, an important goal in its own right, since those plants account for almost all the coal-fired generating capacity in the United States and abroad. However, these plants will age, and demand for new sources of electricity will continue throughout the world. If coal is to be a fuel source of the future and if CO_2 emissions are to be controlled, developing new plants with improvements over today's conventional technology, such as that offered by IGCC, might also be an important goal.

In weighing different goals to address the technological barriers that are associated with clean-coal technology, it is also important to recognize that technology must be considered in conjunction with other barriers, most notably legal and regulatory uncertainties over carbon capture and storage and the absence of a national strategy to control CO_2 emissions. That would provide the incentive for carbon capture and storage.

As policy-makers consider a path forward for clean-coal technologies, including the original concept of FutureGen, a comprehensive analysis of the associated costs, benefits, and risks in this context is most important.

Mr. Chairman, this completes my remarks. I have submitted a written statement and a copy of our report for your record.

[The prepared statement of Mr. Gaffigan follows:]

PREPARED STATEMENT OF MARK GAFFIGAN

Mr. Chairman and Members of the Subcommittee:

Thank you for the opportunity to discuss our recent report on the Department of Energy's (DOE) decision to restructure the FutureGen program.[1] As requested, my remarks will focus on that report, which examined (1) the goals of the original and restructured FutureGen programs, (2) the similarities and differences between the restructured FutureGen program and other DOE carbon capture and storage programs, and (3) the extent to which DOE used sufficient information to support its decision to restructure the FutureGen program.

As you know, Mr. Chairman, coal is currently the world's leading source of electricity. Coal-fired power plants generate about one-half of the electricity used in the United States, as well as about one-third of the Nation's carbon dioxide (CO_2) emissions, which contribute to climate change. In 2003, DOE initiated FutureGen—a program to design, build, and operate a commercial-scale, coal-fired power plant that incorporated carbon capture and storage (CCS) with integrated gasification combined cycle (IGCC), an advanced technology for generating electricity that has been deployed on a commercial scale at only two coal-fired power plants in the United States.[2] In IGCC power plants, coal is gasified to produce a synthesis gas, consisting primarily of hydrogen, carbon monoxide, and CO_2. Then, in a process called precombustion CCS, the CO_2 is removed and separated from the synthesis gas before the synthesis gas is burned in a combustion turbine to generate electricity. Through IGCC, electricity is generated more efficiently than through conventional pulverized coal-fired technology, the process most widely in use, because IGCC uses less coal to generate the same amount of electricity.

The original FutureGen plant was to capture and store underground about 90 percent of its CO_2 emissions. DOE's cost share was to be 74 percent, and industry partners agreed to fund the rest. Concerned about escalating costs, DOE announced in January 2008 that it had decided to restructure FutureGen. In October 2008, DOE received a small number of applications for the restructured FutureGen; however, some of these applications were for proposals outside the restructured FutureGen's scope. As we reported, DOE is currently assessing proposals received and stated it expected to announce a selection of projects by December 2008; however, as of the beginning of March 2009, it had made no decision. DOE requested supplemental information from restructured FutureGen applicants, which will be reviewed before any selection decision.[3] As you know, the recently enacted *American Recovery and Reinvestment Act of 2009,* known as the stimulus law, provides DOE an additional $3.4 billion for "Fossil Energy Research and Development."[4] Such a substantial amount of funding could significantly impact DOE's decisions about how to move forward with programs such as FutureGen.

Our report provides detailed information about our findings. In summary, we found the following:

- The overall goals of the original and restructured FutureGen programs are largely similar in that both programs seek to produce electricity from coal with near-zero emissions by using CCS, and to make that process economically viable for the electric power industry. However, the programs have different approaches for achieving their goals, which could have different impacts on the commercial advancement of CCS and, therefore, result in two largely distinct programs. First, the original program focused on researching and developing the integration of IGCC and CCS at a new, commercial-scale, coal-fired power plant, while the restructured FutureGen aims at demonstrating the use of CCS technology at one or more new or existing commercial coal-fired power plants. As a result, the restructured program could provide opportunities to learn about CCS at different plants, including those that use IGCC and conventional ones that use pulverized coal generating technology. However, under the restructured program, learning about the integration of IGCC and CCS would be possible only if DOE received

[1] GAO, *Clean Coal: DOE's Decision to Restructure FutureGen Should Be Based on a Comprehensive Analysis of Costs, Benefits, and Risks,* GAO–09–248 (Washington, D.C.: Feb. 13, 2009).

[2] Currently, only two IGCC plants operate at commercial scale in the United States. In service since 1997, the Polk Station, near Mulberry, Florida, can provide 250 megawatts to the electric grid. The Wabash River Coal Gasification Repowering Project is the first full-size commercial gasification-combined cycle plant built in the United States, having begun operations in November 1995. The plant, located outside West Terre Haute, Indiana, can provide 262 megawatts to the electric grid.

[3] DOE has identified certain details regarding the negotiations for both the original and the restructured FutureGen as sensitive or proprietary information. Due to the ongoing nature of these negotiations for the restructured FutureGen and the fact that disclosure of sensitive/proprietary information could adversely affect negotiations of these projects and related future projects, our discussion of some aspects of these negotiations is necessarily general.

[4] Pub. L. No. 111–5, tit. IV, 123 Stat. 115, 139 (2009).

applications proposing IGCC and selected one for funding. Second, it is unclear which of the two programs would advance the broader roll out of CCS across industry more quickly. In particular, the original program was to be operated by a nonprofit consortium of some of the largest coal producers and electric power companies in the world at one plant, while the restructured program called for CCS projects at multiple commercial plants. DOE officials told us that the original program would likely have improved the global advancement of CCS more quickly than the restructured program because of its various international partnerships and that DOE is developing an approach to recoup the loss of international involvement that resulted from restructuring FutureGen. Finally, the original FutureGen would have served as an operating laboratory host facility for (1) emerging technologies aimed at the goal of near-zero emissions (such as hydrogen fuel cells and advanced gasification) and (2) gaining broad industry acceptance for these technologies. In contrast, the restructured FutureGen would not include a facility for testing these technologies, and its ability to advance them would, therefore, be limited.

- DOE manages a portfolio of clean coal programs that research and develop CCS technology or demonstrate its application. The restructured FutureGen differs in important ways from most of DOE's other CCS programs, with the exception of one program—Round III of the Clean Coal Power Initiative (CCPI). Both the restructured FutureGen and CCPI (1) fund the commercial demonstration of CCS at new or existing coal-fired power plants and (2) require industry participants to bear at least 50 percent of costs. We reported that the restructured FutureGen targets a higher amount of CO_2 to be captured and stored (at least 1 million metric tons stored annually, per plant) than CCPI does (300,000 metric tons of CO_2 stored or put to use annually, such as to enhance oil recovery, per plant). However, CCPI's goals may be more achievable for industry partners than those of the restructured FutureGen and, therefore, lead to more industry participation. Regarding the restructured program's differences from most of the other CCS programs, the restructured FutureGen would integrate key components of CCS at commercial coal-fired power plants, such as CO_2 capture, compression, transport, storage, and monitoring of stored CO_2. In contrast, most of DOE's other CCS programs concentrate on developing individual components of CCS, such as CO_2 storage, and/or an individual component and a related one, such as capture and compression.
- Contrary to best practices, DOE did not base its decision to restructure FutureGen on a comprehensive analysis of factors such as the associated costs, benefits, and risks. DOE based its decision largely on its conclusion that costs for the original FutureGen had doubled and would escalate substantially. However, this conclusion was problematic because it was derived from a comparison of two cost estimates for the original FutureGen that were not comparable; DOE's $950 million estimate was in constant 2004 dollars, while the $1.8 billion estimate of DOE's industry partners was inflated through 2017. As a result, DOE has no assurance that the restructured FutureGen is the best option to advance CCS. In contrast, DOE's Office of Fossil Energy had identified and analyzed 13 other options for incremental, cost-saving changes to the original program, such as reducing the CO_2 capture requirement. While the Office of Fossil Energy did not consider all of these options to be viable, it either recommended or noted several of them for consideration, with potential savings ranging from $30 million to $55 million each.

Conclusions

According to various energy experts, for the foreseeable future, because coal is abundant and relatively inexpensive, it will remain a significant fuel for the generation of electric power in the United States and the world. However, coal-fired power plants are a significant source of CO_2 and other emissions responsible for climate change. Hence, for at least the near-term, any government policies that address climate change will need to have a goal of significantly reducing CO_2 and other emissions from coal-fired power plants. While CCS is still in its infancy, it may be a promising technology to achieve these purposes. By integrating IGCC and CCS technology at an operating laboratory host facility, DOE's original FutureGen program was intended to address significant technological, cost, and regulatory issues associated with the implementation of CCS at a new plant. Alternatively, the restructured FutureGen left open the possibility of successfully applying CCS technology to existing conventional, pulverized coal-fired power plants—an important goal in its own right, since those plants account for almost all of the coal-fired generating capacity in the United States and abroad. However, DOE's decision to restructure FutureGen and remove the program's emphasis on integrating IGCC and CCS technology was not well documented or explained, in light of the fact that DOE already had existing programs to address CCS at existing coal-fired power plants.

Given the magnitude of the current fiscal and economic challenges facing our nation, along with the urgent need to secure an adequate and sustainable energy supply that does not contribute to climate change, much rides on the success of clean coal programs, such as FutureGen. To ensure the best uses of billions of federal dollars, informed and thoughtful approaches should be taken when making decisions about these programs, including the restructuring of FutureGen. Such informed decision-making has become even more critical with the important opportunity that over $3 billion in additional funding for fossil energy research and development in the recently enacted stimulus law provides DOE for promoting cleaner forms of power generation.

Along these lines, to help DOE make more fully informed decisions on how best to move forward with FutureGen, our February 2009 report recommended that DOE conduct a comprehensive analysis of different options. Specifically, to help ensure the widespread commercial advancement of CCS while protecting taxpayer interests, we recommended that, before implementing significant changes to FutureGen or obligating additional funds for such purposes, the Secretary of Energy direct DOE staff to prepare a comprehensive analysis comparing the relative costs, benefits, and risks of a range of options, including the original and restructured FutureGen programs and incremental options for modifying the original program. We also recommended that the Secretary consider the results of the comprehensive analysis and base any decisions that would alter the original FutureGen on the most advantageous mix of costs, benefits, and risks resulting from the options evaluated. In reviewing a draft of our report, DOE did not comment on the report's recommendations.

In performing our work, we reviewed best practices for making programmatic decisions, FutureGen plans and budgets, and documents on the restructuring of FutureGen. We also contacted DOE, industry partners, and experts. We conducted this performance audit from June 2008 to February 2009, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Mr. Chairman, this completes my prepared statement. I would be happy to respond to any questions you or other Members of the Subcommittee may have at this time.

Ernie Hazera (Assistant Director), Nancy Crothers, and Chad M. Gorman made key contributions to this testimony. Harold Brumm, Jr., Cindy Gilbert, Angela Miles, Timothy Persons, Karen Richey, Michael Sagalow, and Jeanette M. Soares also made important contributions.

United States Government Accountability Office

GAO

Report to Congressional Requesters

February 2009

CLEAN COAL

DOE's Decision to Restructure FutureGen Should Be Based on a Comprehensive Analysis of Costs, Benefits, and Risks

GAO

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GAO-09-248

GAO Accountability·Integrity·Reliability

Highlights

Highlights of GAO-09-248, a report to congressional requesters

February 2009

CLEAN COAL

DOE's Decision to Restructure FutureGen Should Be Based on a Comprehensive Analysis of Costs, Benefits, and Risks

Why GAO Did This Study

Coal-fired power plants generate about one-half of the nation's electricity and about one-third of its carbon dioxide (CO_2) emissions, which contribute to climate change. In 2003, the Department of Energy (DOE) initiated FutureGen—a commercial-scale, coal-fired power plant to incorporate integrated gasification combined cycle (IGCC), an advanced generating technology, with carbon capture and storage (CCS). The plant was to capture and store underground about 90 percent of its CO_2 emissions. DOE's cost share was 74 percent, and industry partners agreed to fund the rest. Concerned about escalating costs, DOE restructured FutureGen. GAO was asked to examine (1) the original and restructured programs' goals, (2) similarities and differences between the new FutureGen and other DOE CCS programs, and (3) if the restructuring decision was based on sufficient information.

GAO reviewed best practices for making programmatic decisions, FutureGen plans and budgets, and documents on the restructuring of FutureGen. GAO contacted DOE, industry partners, and experts.

What GAO Recommends

GAO recommends that DOE re-examine its restructuring decision, based on the comparative costs, benefits, and risks of the original and restructured programs, as well as other incremental options for modifying the original program. DOE provided technical comments but did not comment on the report's recommendations.

To view the full product, including the scope and methodology, click on GAO-09-248. For more information, contact Mark E. Gaffigan at (202) 512-3841 or gaffiganm@gao.gov.

What GAO Found

The original FutureGen program and the new restructured FutureGen program attempt to use CCS at coal-fired power plants to achieve near-zero CO_2 emissions and to make CCS economically viable. However, they take different approaches that could affect CCS's commercial advancement. First, the original program aimed at developing knowledge about the integration of IGCC and CCS at one plant; in contrast, the new program could provide opportunities to learn about CCS at different plants, such as conventional ones that use pulverized coal generating technology. Second, the original program was operated by a nonprofit consortium of energy companies at one plant, while the new program called for CCS projects at multiple commercial plants.

The new, restructured FutureGen differs from most DOE CCS programs. The new FutureGen would develop and integrate multiple CCS components at coal-fired plants (including CO_2 capture, transportation, and storage underground). Other programs concentrate on only one CCS component and/or a related component (e.g., capture or capture and compression). However, Round III of DOE's Clean Coal Power Initiative (CCPI) is a cost-shared partnership with industry that funds commercial CCS demonstrations at new and existing coal-fired plants. The new FutureGen is most like CCPI in that both fund CCS commercial demonstrations at several plants to accelerate CCS deployment and require that participants bear 50 percent of the costs, but DOE expects the new FutureGen to have more funding for commercial demonstrations than CCPI. Moreover, the new FutureGen targets a higher amount of CO_2 to be captured and stored (at least 1 million metric tons of CO_2 annually per plant) than CCPI (300,000 metric tons).

Contrary to best practices, DOE did not base its decision to restructure FutureGen on a comprehensive analysis of factors, such as the associated costs, benefits, and risks. DOE made its decision, largely, on the conclusion that costs for the original FutureGen had doubled and would escalate substantially. However, in its decision, DOE compared two cost estimates for the original FutureGen that were not comparable because DOE's $950 million estimate was in constant 2004 dollars and the $1.8 billion estimate of DOE's industry partners was inflated through 2017. As its restructuring decision did not consider a comprehensive analysis of costs, benefits, and risks, DOE has no assurance that the restructured FutureGen is the best option to advance CCS. In contrast to the restructuring decision, DOE's Office of Fossil Energy had identified and analyzed 13 options for incremental, cost-saving changes to the original program, such as reducing the CO_2 capture requirement. While the Office of Fossil Energy did not consider all of these options to be viable, it either recommended or noted several of them for consideration, with potential savings ranging from $30 million to $55 million each.

Contents

Abbreviations

Alliance	FutureGen Industrial Alliance
Btu	British Thermal Units
CCPI	Clean Coal Power Initiative
CCS	carbon capture and storage
CO_2	carbon dioxide
DOE	Department of Energy
EOR	enhanced oil recovery
FE	Office of Fossil Energy
IGCC	Integrated Gasification Combined Cycle
IPCC	Intergovernmental Panel on Climate Change
NEPA	National Environmental Policy Act of 1969
NETL	National Energy Technology Laboratory
syngas	synthesis gas

GAO
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United States Government Accountability Office
Washington, DC 20548

February 13, 2009

The Honorable Bart Gordon
Chairman
Committee on Science and Technology
House of Representatives

The Honorable Brian Baird
Chairman
Subcommittee on Energy and Environment
Committee on Science and Technology
House of Representatives

The Honorable Daniel Lipinski
House of Representatives

The Honorable Jerry Costello
House of Representatives

Key scientific assessments have underscored the urgency of reducing carbon dioxide (CO_2) emissions to help mitigate climate change. Given the United States' heavy reliance on coal-fired power plants, which emit significant quantities of CO_2, many of these scientific assessments have cited carbon capture and storage (CCS), a developing technology, as a crucial component of any strategy for addressing climate change. CCS involves separating CO_2 from other gases emitted in power plants; capturing the CO_2; compressing it into a liquid form; transporting it (for example, by pipeline) to suitable locations; injecting it into deep underground geologic formations, such as depleted oil reservoirs and saline formations, for long-term storage; and finally, monitoring the presence of the CO_2 at the storage site for a long period of time. Developing CCS is particularly important since total world CO_2 emissions are expected to increase significantly in the near future as the United States continues to use its large coal reserves and as rapidly developing countries, such as China and India, increasingly rely on coal to generate electricity. To date, however, CCS has not been demonstrated on a commercial scale at a power plant, although key stakeholders, such as the International Energy Agency, an organization that advises 28 member countries on energy policy, have noted the importance of commercial-scale demonstration projects for advancing the technology's widespread commercialization.

In 2003, the Department of Energy (DOE) announced its FutureGen program as a $1 billion venture, partnering with the electric power industry to design, build, and operate the world's first coal-fired, zero-emissions power plant. In 2005, the FutureGen Industrial Alliance (Alliance), a nonprofit consortium of some of the largest coal producers and electric power companies in the world, formed to join DOE in this effort. The Alliance agreed to fund 26 percent of the program, and DOE agreed to fund the remaining 74 percent—of which DOE anticipated receiving funding contributions for about 8 percent of the program's total cost from foreign government partners. The agreement was subject to renegotiation and renewal or continuation by both DOE and the Alliance at various stages. In addition to FutureGen, DOE has other clean coal programs with CCS components. For example, Round III of the Clean Coal Power Initiative (CCPI) seeks cost-shared partnerships with industry to fund commercial CCS demonstration at coal-fired power plants.

FutureGen was originally conceived as a research and development project to integrate CCS with another developing technology—integrated gasification combined cycle (IGCC)—in a single power plant at commercial scale.[1] In IGCC power plants, coal is gasified to produce a synthesis gas (syngas), consisting primarily of hydrogen, carbon monoxide, and CO_2. In a process called precombustion CCS, the CO_2 is removed and separated from the syngas before the gas is burned in a combustion turbine to generate electricity. Through IGCC, electricity is generated more efficiently than through conventional pulverized coal-fired technology, the process most widely in use, because IGCC uses less coal to generate the same amount of electricity. In addition, oxygen-fired IGCC plants produce CO_2 as a concentrated gas stream at high pressure that may be captured and stored more easily and cheaply than CO_2 from a typical pulverized coal-fired power plant, which emits CO_2 that must be separated from other gases before storing. Construction on FutureGen was scheduled to begin in 2009, and operations were to begin in 2012. In that year, FutureGen was to begin capturing, storing, and monitoring the stored CO_2 for 3 to 5 years, and then continue monitoring the stored CO_2 for 2 more years. In addition, the FutureGen plant was being designed to serve

[1]Currently, only two IGCC plants operate at commercial scale in the United States. In service since 1997, the Polk Station, near Mulberry, Florida, can provide 250 megawatts to the electric grid. The Wabash River Coal Gasification Repowering Project is the first full-size commercial gasification-combined cycle plant built in the United States, having begun operations in November 1995. The plant, located outside West Terre Haute, Indiana, can provide 262 megawatts to the electric grid.

as a living laboratory host facility for emerging clean coal research programs, including DOE's ongoing coal research program, to help develop advanced technologies that could (1) improve CCS and IGCC, and (2) advance research in other areas, such as hydrogen fuel cells.

By mid-2007, partly because of cost escalations for building power plants around the world, DOE had become increasingly concerned about potential escalating costs for FutureGen. For example, the price of cement, large quantities of which are required for building power plants, had increased by about 30 percent from 2004 to 2006, and certain labor costs for building power plants had increased by over 25 percent, or almost twice the rate of general inflation, from 2001 to 2007. In October 2007, to address these concerns, DOE began renegotiating its share of program costs with the Alliance. In December 2007, after DOE finished conducting the extensive environmental analyses required by the National Environmental Policy Act of 1969 (NEPA)[2] of four potential sites that took over a year, the Alliance announced that it had selected Mattoon, Illinois, for the location of FutureGen. However, DOE had not yet issued its NEPA Record of Decision.[3] Further, DOE had advised the Alliance not to announce a site selection until the Record of Decision had been issued, as contemplated by the cooperative agreement. Subsequently, in January 2008, DOE announced that it would not continue its cooperative agreement with the Alliance and that it was going to take a different approach to FutureGen. DOE stated that this decision was based on concerns over potential cost escalations and the need to more quickly advance commercial technology.

DOE's new approach—the restructured FutureGen—focuses on demonstrating CCS at multiple new or existing commercial coal-fired power plants that may use IGCC or other types of coal plants, such as existing pulverized coal-fired power plants, which comprise 99 percent of all existing coal-fired power plants in the United States. Under the

[2]Pub. L. No. 91-190 (1970). Under the act, federal agencies must evaluate the likely environmental effects of their activities using an environmental assessment or, if the activity likely would significantly affect the environment, a more detailed environmental impact statement.

[3]The cooperative agreement originally scheduled the final site announcement to take place on September 4, 2007, contingent upon DOE's August 1, 2007, publication of the Record of Decision. On November 9, 2007, DOE issued a press release announcing the completion of its final environmental impact statement for FutureGen and that DOE anticipated site selection would be made later that year.

restructured FutureGen, DOE would fund several projects proposed by industry, including entities such as electric power companies, to add CCS to commercial power plants. The plants would begin using CCS by the end of 2015; and, as planned under the original FutureGen, they would be required to capture, store, and monitor the stored CO_2 for 3 to 5 years, and to continue monitoring the stored CO_2 for an additional 2 years. In June 2008, DOE announced that it anticipated providing up to $1.3 billion for the entire restructured FutureGen program, with certain caps in funding for each individual project. The original FutureGen was a DOE research and development project, but the restructured FutureGen is a DOE commercial demonstration project. Under the Energy Policy Act of 2005, a nonfederal source must generally fund not less than 20 percent of a DOE research and development project and not less than 50 percent of a DOE demonstration and commercial application project—that is, industry partners share more of the costs of demonstration projects.[4] However, with both the original and restructured FutureGen, a nonfederal source must pay at least 50 percent of any demonstration component's cost.[5] In October 2008, DOE received a small number of applications for the restructured FutureGen; however, some of these applications are for proposals outside of the restructured FutureGen's scope. DOE is currently assessing proposals received and had stated it expected to announce a selection of projects by December 2008; however, as of the beginning of February 2009, it had made no decision. DOE requested supplemental information from restructured FutureGen applicants which will be reviewed prior to any selection decision.[6]

While IGCC is a promising technology for generating electricity from coal, currently, coal-fired electricity is almost exclusively generated in existing pulverized coal-fired power plants. In these plants, pulverized coal is combusted in air to boil water, which raises steam that, in turn, is routed

[4]Pub. L. No. 109-58 (2005), *codified at* 42 U.S.C. § 16352.

[5]In addition, beginning in fiscal year 2005, costs for the initial planning and research stages were subject to a 20 percent nonfederal cost share. According to DOE, for the restructured FutureGen, not less than a 50 percent nonfederal cost-share for all stages will be required.

[6]DOE has identified certain details regarding the negotiations for both the original and the restructured FutureGen as sensitive or proprietary information. Due to the ongoing nature of these negotiations for the restructured FutureGen and the fact that disclosure of sensitive/proprietary information could adversely affect negotiations of these projects and related future projects, our discussion of some aspects of these negotiations is necessarily general

to turbines to generate electricity. The CO_2 that results from burning coal is exhausted in the flue gas at atmospheric pressure.

In addition to generating electricity in pulverized coal-fired plants or utilizing IGCC technology, oxyfuel combustion is another developmental technology not yet deployed at a commercial scale that could burn pulverized coal to generate electricity. In oxyfuel combustion plants, coal would be burned in pure oxygen diluted with recycled CO_2 or water. Oxyfuel combustion technology could also be one of the technologies considered by DOE in its CCS research efforts, including the restructured FutureGen.

You asked us to examine (1) the goals of the original and restructured FutureGen programs, (2) the similarities and differences between the restructured FutureGen program and other DOE carbon capture and storage programs, and (3) the extent to which DOE used sufficient information to support its decision to restructure the FutureGen program.

In conducting our work, we reviewed FutureGen appropriations, cost estimates, budget justifications, and other DOE documents, including the cooperative agreement and proposed terms for renegotiating the agreement between DOE and the Alliance. We also met with officials from DOE's Office of Fossil Energy (FE), including the National Energy Technology Laboratory (NETL) and the Office of Clean Coal, in addition to officials from the Alliance. We conducted semi-structured interviews with 14 knowledgeable stakeholders from the electric power and coal industries, nonprofit research organizations, academia, and others to determine, among other things, the potential benefits of and key differences between the original and restructured FutureGen programs. We also reviewed public responses to DOE's request for information about the restructured FutureGen and its funding announcement. Finally, we reviewed our recent work and guidance on best practices for cost estimation, program management, and programmatic decision making. A more detailed description of our scope and methodology is presented in appendix I.

We conducted this performance audit from June 2008 to February 2009, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Results in Brief

The overall goals of the original and restructured FutureGen programs are similar in that both programs aim to produce electricity from coal with near-zero emissions by using CCS and to make that process economically viable for the electric power industry. However, the two programs would take different approaches to achieving their goals resulting in, according to knowledgeable stakeholders, two largely distinct programs that could affect aspects of the commercial advancement of CCS differently in the following ways:

- *Type of information gained.* The original FutureGen aimed at developing knowledge about the integration of IGCC and CCS at one power plant. In contrast, the restructured FutureGen could provide opportunities to learn about CCS at different types of coal-fired power plants because the program would be open to coal-fired plants utilizing technologies other than IGCC, such as conventional pulverized coal and oxyfuel combustion. However, under the restructured program, learning about the integration of IGCC and CCS is only possible if DOE receives applications proposing IGCC and selects one for funding.
- *Speed of widespread commercialization of CCS.* It is unclear whether the original FutureGen program or the restructured program would advance the broader roll out of CCS across all of industry more quickly. According to DOE documents, the restructured program is to begin deploying CCS at one or more commercial facilities that generate power for sale in 2015, approximately 5 years earlier than the original program's commercial operations could begin. However, the original program would have begun generating, if not marketing, electricity in 2012. Also, unlike the restructured program, the original program through the Alliance would have included a wide variety of industry and international partnerships, thereby fostering widespread commercialization of CCS technology and the use of that technology.
- *Testing advanced technology.* The original FutureGen would have served as a living laboratory host facility for emerging technologies, aimed at the goal of near-zero emissions (such as hydrogen fuel cells), and for gaining broad industry acceptance for these technologies. In contrast, the restructured FutureGen would not include a facility for testing these technologies, and its ability to advance them would, therefore, be limited.

The restructured FutureGen differs in important ways from most of DOE's other CCS programs, with the exception of one program—Round III of CCPI. Both the restructured FutureGen and CCPI (1) fund the commercial demonstration of CCS at coal-fired power plants, and (2) require industry participants to bear at least 50 percent of costs. The restructured

FutureGen would potentially have more available funding for commercial demonstrations than CCPI, and the restructured FutureGen targets a higher amount of CO_2 to be stored (at least 1 million metric tons of CO_2 stored annually, per plant) than CCPI (300,000 metric tons of CO_2 stored or put to use annually, per plant). However, because CCPI's goals may be more realistic or attainable for commercial partners than those of the restructured FutureGen, CCPI may receive more proposals and, hence, more industry participation. Regarding the restructured program's differences from most of the other CCS programs, the restructured FutureGen would integrate key components of CCS at commercial coal-fired power plants, such as CO_2 capture, compression, transport, storage, and monitoring of stored CO_2; in contrast, most of DOE's other CCS programs concentrate on developing individual components of CCS, such as CO_2 storage, and/or an individual component and a related one, such as capture and compression.

DOE did not use sufficient information to support its decision to restructure FutureGen. According to our recent work and best practices, a decision to terminate or significantly restructure an ongoing program should be informed by timely and sufficient information on the costs, benefits, and risks of such a decision.[7] DOE did not prepare a comprehensive analysis of the costs, benefits, and risks of its decision to replace the original FutureGen with the restructured program. DOE made its decision based, in large part, on its conclusion that construction and material costs for the original program would continue escalating substantially in the indefinite future and that life-cycle costs were likely to double. However, according to economic forecasting organizations, such as DOE's Energy Information Administration, significant cost escalations for building power plants, in general, do not typically continue in the long run. Also, DOE reached this conclusion by comparing its cost estimate for the original FutureGen ($950 million in constant 2004 dollars) with the Alliance's 2006 estimated life-cycle costs for the program through 2017 (about $1.8 billion, considering inflation). In explaining his decision to restructure FutureGen, the Secretary of Energy noted that the projected

[7]GAO, *Defense Acquisition: Termination Costs Are Generally Not a Compelling Reason to Continue Programs or Contracts That Otherwise Warrant Ending*, GAO-08-379 (Washington, D.C.: Mar. 14, 2008); *Cost Assessment Guide: Best Practices for Estimating and Managing Program Costs—Exposure Draft*, GAO-07-1134SP (Washington, D.C.: July 2, 2007); *Standards for Internal Control in the Federal Government*, GAO/AIMD-00-21.3.1 (Washington, D.C.: Nov. 1, 1999); and *Executive Guide: Leading Practices in Capital Decision-Making*, GAO/AIMD-99-32 (Washington, D.C.: Dec. 1, 1998).

program cost had "nearly doubled," from $950 million to $1.8 billion. However, that assertion did not take into account a major difference between the two estimates: one was based on constant dollars and the other on inflated dollars. Our analysis indicates that the Alliance's estimate in constant 2005 dollars would be approximately $1.3 billion—an increase of about $370 million, or about 39 percent, over DOE's estimate, not a near doubling of costs. As DOE's restructuring decision was not based on a comprehensive analysis of the associated costs, benefits, and risks, DOE has no assurance that the restructured program is the best option to accomplish the goal of promoting the accelerated and widespread commercial advancement of CCS. In contrast to the restructuring decision, FE identified and analyzed 13 other options for incremental, cost-saving changes to the original program, such as reducing the CO_2 capture requirement. While FE did not consider all of these options to be viable, it either recommended or noted several of them for consideration, each with potential savings from $30 million to $55 million.

To help ensure the widespread commercial advancement of CCS while protecting taxpayer interests, we are recommending that, before implementing significant changes to FutureGen or before obligating additional funds for such purposes, the Secretary of Energy should direct DOE staff to prepare a comprehensive analysis comparing the relative costs, benefits, and risks of a range of options, including the original and restructured FutureGen programs and incremental options for modifying the original program.

In commenting on a draft of this report, DOE thanked us for the opportunity to review the draft. In its response, DOE did not provide comments on the report's conclusions or recommendations. However, DOE provided us with technical comments, which we have incorporated into the report, as appropriate. See appendix III for DOE's comments and our response to these comments.

Background

Global emissions of greenhouse gases, such as CO_2, from human activities have grown markedly since preindustrial times—since about the year 1750—with an increase of 70 percent from 1970 to 2004. Most scientists agree that increased greenhouse gases in the atmosphere are the primary cause of the rise in global temperatures in recent decades. The Intergovernmental Panel on Climate Change (IPCC) expects greenhouse gas emissions to continue to increase over the next few decades, resulting in a continued rise in global temperatures and related harmful impacts, including the flooding of large populated coastal areas, a reduction in the production of some crops and livestock productivity, and a decrease in the availability of fresh water in certain parts of the world.

According to the National Academy of Sciences, CO_2 levels in the atmosphere are currently at their highest in at least 650,000 years and are continuing to rise. Global increases in concentrations of CO_2 in the atmosphere are due primarily to the burning of fossil fuels—such as petroleum and coal—for energy, industrial processes, and transportation. Coal is currently the world's leading source of electricity, and the use of coal to generate electricity around the world is projected to double by 2030. Coal-fired power plants provide about one-half of the supply of electricity used in the United States, and DOE's Energy Information Administration estimates that coal accounts for approximately one-third of the total CO_2 emissions in the United States. In addition, the International Energy Agency anticipates that the two largest developing countries—China and India—will drive increased demand for coal to meet their growing electricity needs. According to the International Energy Agency, these countries' heavy reliance on coal has already contributed significantly to recent increases in global CO_2 emissions.

To prevent the anticipated increase in coal-fired electricity generation from emitting significant amounts of CO_2 into the atmosphere, many are suggesting CCS as a tool that allows for continued coal use, while mitigating its effect on the climate.[7] CCS comprises several components: separating CO_2 from other gases emitted by the plant; capturing emitted CO_2; compressing the CO_2 into a fluid state to facilitate its transportation; transporting it to a storage location; injecting the CO_2 into geologic formations, such as depleted oil and gas reservoirs and saline formations, for storage; and monitoring the storage site to verify that the CO_2 remains in place. A successful CCS system must integrate all of these components.

Currently, three major approaches have been identified for capturing CO_2 at coal-fired power plants: (1) generating electricity using pulverized coal as a fuel in conventional power plants with postcombustion capture of CO_2, (2) generating electricity using IGCC technology with precombustion

[7]The International Energy Agency identifies CCS and other clean coal technologies as one of the most promising routes for mitigating emissions and notes that, "CCS could reconcile continued coal burning with the need to cut emissions in the longer term." Similarly, the IPCC notes that CCS would help preserve existing energy infrastructure, thereby restraining the cost of emissions reductions.

capture of CO_2, and (3) using pulverized coal as a fuel in power plants that utilize oxyfuel combustion technology to generate power and capture CO_2.

- *Postcombustion capture and pulverized coal-fired power plants:* Pulverized coal-fired power plants, which comprise 99 percent of all existing coal-fired power plants in the United States, burn pulverized coal to boil water, which raises steam that, in turn, is routed to turbines to generate electricity. The CO_2 that results from burning coal is exhausted in the flue gas at atmospheric pressure and a concentration of 10 to 15 volume percent. Postcombustion capture of CO_2 occurs after the coal is burned. The technology for capturing the CO_2 could be retrofitted onto existing power plants. However, according to DOE, the postcombustion capture of CO_2 is a challenging approach because (1) the low pressure and dilute concentration dictate a high actual volume of gas to be treated; (2) trace impurities in the flue gas tend to reduce the effectiveness of the CO_2 adsorbing processes; and (3) compressing captured CO_2 from atmospheric pressure to pipeline pressure (about 1,200 to 2,000 pounds per square inch) requires a large amount (an estimated 20 to 40 percent) of the electric power generated by the power plant.[9]
- *Precombustion capture and IGCC power plants*: This approach would be used at coal plants that use IGCC, a technology for generating electricity that has been deployed on a commercial scale at only two coal-fired power plants in the United States. In an IGCC plant, coal is gasified through a thermochemical process to break it down into its chemical constituents and produce a synthesis gas (syngas) which consists mostly of hydrogen, carbon monoxide, and CO_2.[10] The syngas is then treated to remove contaminants, such as ammonia and mercury, and burned in a combustion turbine to generate electricity. Precombustion capture in IGCC plants can occur because the CO_2 in the syngas is at a very high pressure, which allows it to be captured before the combustion of the syngas.

[9] Regardless of the approach used to generate electricity and capture CO_2, additional electricity, often referred to as the energy penalty or parasitic power, is required for capture and compression.

[10] ICGG plants can be either air-blown or oxygen-blown, referring to the way in which oxygen is introduced into the gasifier. The syngas produced in an air-blown gasifier consists primarily of inert nitrogen, along with hydrogen, carbon monoxide, low levels of CO_2, and water vapor. In oxygen-blown gasification, the syngas is comprised of the same primary components, but has very little nitrogen and is, therefore, more concentrated in respect to the other components.

- *Oxyfuel combustion*: Oxyfuel combustion, which is in its developmental stages, is a technology that is being developed for using coal to generate electricity that could reduce CO_2 emissions. According to DOE, oxyfuel combustion could be applied to existing pulverized coal-fired plants. Oxyfuel combustion burns coal using pure oxygen diluted with recycled CO_2 or water. As a result, oxyfuel combustion emits primarily CO_2 and water vapor, with some excess oxygen, facilitating the capture of the CO_2 by condensing the water in the exhaust stream. Because separating out the CO_2 is not necessary under this approach, the CO_2 capture consists essentially of drying and compressing the CO_2. However, depending on the level of excess oxygen and other trace components, some additional gas cleanup may be required to make the CO_2 suitable for transportation.

After being captured, the CO_2 would be transported, likely via pipeline, to a storage site and injected at depths of over 800 meters (or about 2,600 feet) into underground geologic formations (such as depleted oil reservoirs and saline formations), thought to be conducive for isolating the CO_2 for hundreds to thousands of years. We reported in 2008 that among the barriers to CCS deployment are regulatory and legal uncertainties regarding the liability for CO_2 leakage and the ownership of CO_2, once injected. Once injected, the CO_2 must be monitored to ensure it does not escape into the environment.[11]

On February 27, 2003, the President announced FutureGen as a cost-shared project between DOE and industry to create the world's first coal-fired, zero emissions electricity and hydrogen production power plant. The production of hydrogen was to support the President's Hydrogen Fuel Initiative to create a hydrogen economy for transportation. The original FutureGen plant was planned to operate at a commercial scale as a 275 megawatt IGCC facility that would capture and store at least 1 million metric tons of CO_2 per year. In December 2005, DOE signed a cooperative agreement with the nonprofit Alliance.[12] Pursuant to the agreement, the

[11]GAO, *Climate Change: Federal Actions Will Greatly Affect the Viability of Carbon Capture and Storage As a Key Mitigation Option*, GAO-08-1080 (Washington, D.C.: Sept. 30, 2008).

[12]The Alliance is currently comprised of the following 11 companies that produce coal or generate coal-fueled power on six continents: American Electric Power, Anglo American LLC, BHP Billiton, China Huaneng Group, CONSOL Energy Inc., E.ON U.S., Foundation Coal Corporation, Peabody Energy, Rio Tinto Energy America, Southern Company, and Xstrata Coal Pty Limited. The Alliance membership continues to be open to U.S. and international companies that produce coal or electricity from coal as a significant business activity.

Alliance was to design, construct, and operate the FutureGen plant, and DOE was to provide project oversight, conduct the environmental analyses required by NEPA, and coordinate the participation of foreign governments.[13] The project was to run through November 2017 and operate as the cleanest fossil fuel-fired power plant in the world. After completion of the formal project, the FutureGen plant was expected to continue operating for the typical lifespan of a power plant—usually 30 to 50 years—generating electricity and providing a platform for energy research. On January 30, 2008, DOE announced that it had decided to take the FutureGen program in a different direction. DOE stated that it would demonstrate CCS at multiple commercial-scale power plants, including retaining the integration of CCS and IGCC. DOE referred to this new approach as the restructured FutureGen program. In June 2008, in a funding announcement for the restructured program, DOE stated that it expected it would have about $290 million available through fiscal year 2009 for its share of funding for the program. (See app. II for an overview of DOE budget authority and obligations for FutureGen.)

The Goals of the Original and Restructured FutureGen Programs Are Largely Similar, but the Programs' Different Approaches May Lead to Different Results

The overall goals of the original and restructured FutureGen programs are largely similar in that both programs seek to produce electricity from coal with near-zero emissions by using CCS, and to make that process economically viable for the electric power industry. However, the programs outline different approaches for achieving their goals, which could affect the commercial advancement of CCS differently in several ways.

[13]In 2006 and 2007, DOE received funding contributions for FutureGen from the governments of India and South Korea.

With a Few Key Exceptions, the Goals of the Original and Restructured Programs Are Largely Similar

Both the original and restructured programs aim to establish the feasibility and economic viability of producing electricity from coal with near-zero emissions by employing CCS. The programs' goals for storing CO_2 and limiting other emissions, such as mercury and sulfur, are also similar, except that the requirement for the amount of carbon to be captured has been reduced from 90 percent in the original program to 81 percent in the restructured program (see table 1).

Table 1: Storage and Emissions Goals for the Original and Restructured FutureGen Programs

Storage and emissions goals	Original FutureGen	Restructured FutureGen
Carbon	Capture at least 90%[a]	Capture at least 81%[a]
CO_2	Store at least 1 MMT/year[b]	Store at least 1 MMT/year[b]
Sulfur	Remove at least 99%	Remove at least 99%[c]
Mercury	Remove at least 90%	Remove at least 90%[d]
Btu NOx	Reduce to less than .05 lb/million	Reduce to less than .05 lb/million
Btu particulate matter	Reduce to less than .005 lb/million	Reduce to less than .005 lb/million

Source: GAO analysis of DOE program documents.

[a]The original FutureGen program's goal is to capture 90 percent of the CO_2 in the total plant gas stream, while the restructured FutureGen program requires capture of 81 percent of the carbon in the total plant gas stream. According to DOE officials, the carbon capture goal of the restructured program includes the capture of CO_2, as well as other carbon-based gases—such as methane (CH_4), another greenhouse gas. DOE officials explained that they changed the measure from CO_2 to carbon for clarification purposes and because the restructured FutureGen was designed to accommodate a range of gasification and combustion technology configurations. Also, while the goal for the restructured FutureGen states 90 percent carbon capture, the minimal performance requirement is 81 percent of carbon.

[b]Per demonstration unit or plant.

[c]Based on the sulfur content of the coal, or less than 0.04 lbs/million Btu if there is low sulfur concentration in the coal.

[d]Based on the mercury content of the coal.

Knowledgeable stakeholders told us that this decrease in carbon capture is of modest significance and that a goal of 81 percent is still very ambitious and costly. DOE received similar feedback in responses to its request for information from the public about its plan to restructure FutureGen. Eighteen of the 49 respondents indicated that the 90 percent goal would be too restrictive for industry participants because of the additional energy required to capture and compress CO_2, often referred to as the energy penalty, and the fact that no power plant to date has been designed to operate with the conditions necessary to achieve a 90 percent capture. Some respondents suggested setting a lower capture goal, such as 65 percent, and adopting an incremental approach over time to reach 90 percent that would eventually allow industry to obtain baseline data and demonstrate reliability and widespread confidence in CCS. One respondent wrote that the "90% capture level was appropriate for a 'living laboratory' like the originally proposed FutureGen project but a 30% level is most suitable for a commercial IGCC facility."

Both the original and restructured programs would operate plants at a commercial size.[14] However, the restructured program, a DOE commercial demonstration project, seeks to accelerate the commercial deployment of CCS (that is, generating and selling electricity to earn profits) by implementing CCS at one or more commercial facilities by 2015—approximately five years earlier than the original program's commercial operations could begin. The original program, a DOE research and development project, would begin generating electricity in 2012, a few years earlier than the restructured FutureGen; but, it could not begin operating as a profit-seeking commercial facility until after the nonprofit Alliance sells it, which is currently anticipated to occur in 2020. Knowledgeable stakeholders told us that the restructured program's time-line for the commercial deployment of its project(s) might be ambitious because legal and environmental issues related to siting and permitting, in particular for CCS, could slow implementation. They also stated that the required NEPA analyses, which must be completed prior to beginning construction, could take up to 3 years. In contrast, DOE had completed its NEPA analyses for the original FutureGen. Moreover, the governments of the two states—Texas and Illinois—where the four finalist sites for the original FutureGen were located, had agreed to assume liability for the injected CO_2. DOE officials told us that, unlike the original program, a primary goal of the restructured FutureGen was to facilitate the siting and permitting process for CCS by implementing multiple projects in different locations.

[14]According to DOE, if a non-IGCC plant is selected under the restructured FutureGen, it is only required to be at a scale sufficient to prove commercial viability and be designed to produce and capture 1 million tons of CO_2 per year. IGCC plants would be required to produce at least 300 megawatts of gross electricity output.

The Different Approaches for Achieving Goals Could Have Different Impacts on the Commercial Advancement of CCS

Because of the different approaches for achieving their goals, the original and restructured FutureGen programs could have different impacts on the commercial advancement of CCS (see table 2).

Table 2: Key Differences in the Approaches of the Original and Restructured FutureGen Programs

Original FutureGen	Restructured FutureGen as currently designed
Only includes IGCC.	May or may not include IGCC; IGCC was identified as a goal, but its inclusion in the program depends on the applications received and selected.
Accelerated deployment of CCS at commercial facilities is not a goal.	Accelerated deployment of CCS at commercial facilities is a goal.
Includes a living laboratory host facility for advanced technologies, such as fuel cells.	Does not include a living laboratory host facility for advanced technologies.
Project would be operated by a nonprofit consortium of 11 industry partners (FutureGen Industrial Alliance).	Each project could be operated by a nonprofit or for-profit entity.
Research and development project (DOE cost share capped at 74%).	Demonstration project (DOE cost share capped at 50%).
Consists of one plant.	Potential for multiple sites, depending on the applications received and selected.
Includes international involvement.	No international involvement.

Source: GAO analysis of DOE program documents.

The type of information gained from the programs may vary. First, the original program would have developed knowledge about CCS at IGCC plants, while the restructured program could allow for opportunities to learn about CCS at both IGCC and other types of coal plants. Knowledgeable stakeholders whom we contacted stated that DOE could benefit by taking advantage of the opportunity under the restructured FutureGen program to learn about CCS at multiple types of plants. They explained that opportunities to learn from multiple plant sites in different regions with various technologies would provide a wide range of knowledge about the implementation of CCS in various contexts. Similarly, 30 of 49 respondents to DOE's request for information about the restructured program indicated that it would be beneficial if the restructured program were to include both IGCC and other types of coal plants. In addition to other organizations, such as the National Academy of

Sciences, we have noted that the benefits of learning about CCS technologies are also applicable to existing pulverized coal-fired plants, since they account for an overwhelming share (about 99 percent) of the world's coal-fired power plants.[13] However, one of the intended benefits of the restructured program—providing opportunities to learn from multiple plants about various technologies—may not be fully realized since DOE received only a small number of applications. If an application for IGCC has not been received or is not selected, the loss of an IGCC plant with integrated CCS capability is significant because, according to the draft strategic planning document for the restructured program, demonstrating this technology is a key solution for reducing atmospheric CO_2 emissions from coal-fired power plants. Comments submitted to DOE and knowledgeable stakeholders we interviewed indicated that the carbon capture goal for the restructured program was too restrictive for commercial facilities. One stakeholder stated that the restructured program goals might be overly optimistic about what commercial projects are willing to do. As a result of receiving only a small number of applications, the restructured program is not as likely to develop as broad a base of knowledge as it could have if more applications were received.

Second, it is unclear whether the original FutureGen program or the restructured program could have advanced the broader roll out of CCS more quickly across all of industry. According to DOE documents, the restructured program is intended to begin deploying CCS at one or more commercial facilities in 2015, approximately five years earlier than the original program's commercial operations (that is, generating and selling electricity) could begin. The original program, a DOE research and development project, would have begun generating electricity in 2012, a few years earlier than the restructured FutureGen, but it could not have begun operating as a profit-seeking commercial facility until after the nonprofit Alliance sold it, which was anticipated to occur in 2020. Moreover, unlike the restructured program, the original FutureGen would have included a wide variety of industry partners (including foreign government partners, which are absent from the restructured program). In addition, more industry partners could have joined the Alliance and its 11 members over the course of the original program. As a result of its wider participation, the original FutureGen could potentially have advanced the broader roll out of CCS across all of industry and internationally, instead of at only a few commercial facilities, more quickly

[13] GAO-08-1080.

than the restructured program. DOE officials told us that the original program would likely improve the global advancement of CCS more quickly than the restructured program due to its various international partnerships. They stated that DOE is developing an approach to recoup the loss of international involvement that resulted from restructuring FutureGen.

Third, the restructured program will not serve as a living laboratory host facility for technologies emerging from energy research and development programs aimed at the goal of near-zero emissions and for gaining broad industry acceptance for these technologies. The original FutureGen plant was to be designed with the ability to test various technologies that are scalable to full size, such as fuel cells, advanced gasification, and membrane air separation systems. Without the opportunity to test these emerging research and development technologies, the restructured FutureGen might result in a slower advancement of CCS than the original program may have yielded. According to the cooperative agreement between DOE and the Alliance, emerging technologies, such as fuel cells, could have been tested at the original program's living laboratory host facility. In a September 2007 presentation to DOE's Deputy Secretary, NETL noted the impact of removing the living laboratory, saying it would "significantly delay the availability of the technology for commercial deployment" and have a "significant programmatic impact." DOE officials told us that they have not yet determined where these technologies will be tested.

The Restructured FutureGen Differs from Most of the Other DOE Carbon Capture and Storage Programs, but It Is Similar to CCPI in Several Ways

DOE manages a portfolio of clean coal programs that research and develop CCS technology or demonstrate its application. Focusing on commercial coal-fired power plants, the restructured FutureGen would integrate key components of CCS, such as CO_2 capture, compression, transport, storage, and monitoring of CO_2 at the storage location. However, the restructured FutureGen is similar in some ways to Round III of CCPI, but CCPI's goals are more modest than those of the restructured FutureGen and, hence, may be more achievable for industry partners. The other CCS programs include the (1) Regional Carbon Sequestration Partnerships, (2) Innovations for Existing Plants Program, (3) Advanced Turbines Program, (4) Advanced Integrated Gasification Combined Cycle Program, and (5) Round III of the Title 17 Incentives for Innovative Technologies Loan Guarantee Program (Loan Guarantee Program). Four of these five CCS programs do not integrate all key components of CCS and concentrate on developing one or two related components of CCS, such as CO_2 separation, CO_2 storage, or CO_2 capture with related compression.

The Restructured FutureGen Program Is Similar to Round III of CCPI in Several Ways, but CCPI's Goals May be More Achievable for Industry Partners

Both the restructured FutureGen and CCPI are cost-shared partnerships with industry, in which DOE funds no more than 50 percent of the costs. Like the restructured FutureGen, Round III of the CCPI program funds the commercial demonstration of CCS at coal-fired power plants.[16] Round III of CCPI seeks to demonstrate, at a commercial scale, advanced coal-based technologies that capture and store carbon, or put CO_2 emissions to beneficial reuse, such as to enhance oil recovery.[17] The proposals for Round III of CCPI were due to DOE by January 15, 2009, and DOE expects to announce its selections in July 2009.

In public comments on DOE's request for information and the draft funding announcement for the restructured FutureGen, two respondents noted the similarity between the restructured FutureGen and CCPI. They suggested that DOE explain the linkages and possibly combine the programs. However, important differences exist in the two programs' goals. First, while both programs have annual requirements for the capture of CO_2 emissions, the restructured FutureGen requires 1 million metric tons of CO_2 per plant, while CCPI requires 300,000 metric tons of CO_2 per plant. Knowledgeable stakeholders told us that CCPI's goal of capturing 300,000 metric tons of CO_2 is more realistic and attainable by commercial facilities than the restructured FutureGen's goal of 1 million metric tons. Another noteworthy distinction is that the restructured FutureGen requires the 1 million metric tons of CO_2 emissions to be stored in saline formations, whereas the 300,000 metric tons of CO_2 emissions that CCPI requires to be captured can either be stored or be put to beneficial reuse, such as to enhance oil recovery. The latter opens up more options for industry partners and can serve as an attractive opportunity for increasing revenue in the project by selling the CO_2. Finally, because CCPI's goals

[16]While the first two rounds of CCPI did not focus on CCS, Round III does so through projects that capture and store CO_2 or put CO_2 to beneficial reuse. Round I was broadly focused on advancing technologies in coal-fired power generation that would result in efficiency, as well as environmental and economic improvements. Round II was focused on gasification technology and mercury control.

[17]According to DOE, most oil is produced in three distinct phases: primary, secondary, and tertiary, or enhanced oil recovery (EOR). The definition of tertiary or EOR is that a substance, such as CO_2, is added to the reservoir after secondary recovery in order to increase production. The purpose of EOR is to increase oil production, primarily through an increase in temperature, pressure, or an enhancement of the oil's ability to flow through the reservoir.

may be more realistic or attainable for commercial partners, more proposals may be submitted to CCPI than the restructured FutureGen. For example, two officials from electric utility companies said that, despite the potentially greater amount of funding available through the restructured FutureGen ($1.3 billion, subject to future appropriations) than CCPI ($440 million, subject to future appropriations), their companies would apply for CCPI over the restructured program because they could meet CCPI's goals.

The Restructured FutureGen Differs from Most Other DOE CCS Programs

The restructured FutureGen and other DOE CCS programs strive to reduce CO_2 emissions by advancing CCS. However, while most of these programs do not integrate all key components of CCS, the restructured FutureGen integrates all key components of CCS. The other CCS programs include the (1) Regional Carbon Sequestration Partnerships, (2) Innovations for Existing Plants Program, (3) Advanced Turbines Program, (4) Advanced Integrated Gasification Combined Cycle Program, and (5) Round III of the Title 17 Incentives for Innovative Technologies Loan Guarantee Program.

The Regional Carbon Sequestration Partnerships seek to develop the technology, infrastructure, and regulations necessary to implement CO_2 storage.[13] The 7 regional partnerships are composed of over 350 organizations, 42 states, 4 Canadian provinces, and 3 Native American tribes. Now entering Phase III,[14] the regional partnerships are working to implement 7 large-scale projects that will demonstrate the long-term, effective, and safe storage of CO_2 in the major underground geologic formations throughout the United States and portions of Canada. The CO_2 stored through the projects can come from coal-fired power plants or

[13]We reported in GAO-08-1080 that the regional partnerships program appears to be placing more emphasis on demonstrations of CO_2 capture at coal-fired power plants. Specifically, a DOE official identified three projects being planned to capture CO_2 from coal-fired power plants, including possibly capturing 500,000 metric tons of CO_2 from a coal-fired power plant in North Dakota. Program shifts were also evident in the Innovations for Existing Plants and CCPI programs. We recommended that DOE continue its recent budgetary practice of helping to ensure that greater emphasis is placed on supporting technologies that can reduce greenhouse gas emissions at existing coal-fired power plants.

[14]Phase I of the regional partnerships, the Characterization Phase (2003-2005), focused on describing the potential for CO_2 storage in deep oil-, gas-, coal-, and saline-bearing formations. Phase II, the Validation Phase (2005-2009), is implementing 25 small-scale geologic storage tests. Phase III, the Deployment Phase (2008-2017), is a continuation of the Phase II small-scale tests, but at a much larger scale.

other sources, such as ethanol production plants. The injection of CO_2 into geologic formations will continue over several years, and the monitoring will continue through 2017.

The Innovations for Existing Plants Program focuses on developing CO_2 capture and compression technologies to assist existing coal-fired power plants.[20] Through this program, DOE is providing $36 million in funding for 15 projects to develop new and cost-effective CO_2 capture technologies for existing power plants. According to DOE, all 15 projects selected have received funding. The projects will be implemented across 11 states and will last for 2 to 3 years. Projects will focus on five areas of interest for CO_2 capture: membranes, solvents, sorbents, oxyfuel combustion, and chemical looping.

The Advanced Turbines Program focuses on creating the technology base for turbines that will permit the design of IGCC plants with CCS that can operate at near-zero emissions, thereby facilitating CO_2 capture. According to DOE, the development of new turbines technology could improve applications of IGCC by reducing the costs of producing electricity from coal.

Similarly, the Advanced Integrated Gasification Combined Cycle Program also focuses on one aspect of CCS—developing gasification technology to enable CO_2 capture. The program aims to develop advanced gasification technologies to enable CO_2 capture with minimal impact on the cost of electricity. DOE reports that by 2012, gasification technology will be integrated at pilot scale with CO_2 separation, capture, and sequestration into near-zero atmospheric emissions configurations that can, ultimately, provide electricity with less than a 10 percent increase in cost.

Finally, Round III of the Title 17 Incentives for Innovative Technologies Loan Guarantee Program will provide up to $8 billion in loan guarantees for energy projects that satisfy three criteria: avoid, reduce, or sequester air pollutants or greenhouse gases; employ new or significantly improved technologies, compared with commercial technologies in service at the time the guarantee is issued; and provide a reasonable prospect of

[20]In response to language in the Explanatory Statement accompanying its fiscal year 2008 appropriation, DOE has shifted the focus of the Innovations for Existing Plants program to research and development on CO_2 capture technologies that can be retrofitted to existing pulverized coal-fired power plants.

repayment.[21] Initial applications for Round III of the program were due to DOE in December 2008. We recently reported on DOE's progress in (1) issuing final regulations to govern this program, (2) taking actions to help ensure that the program is managed effectively and to maintain accountability, and (3) determining whether there were inherent risks due to the nature and characteristics of this program that may affect DOE's ability to make the program pay for itself and support a broad spectrum of innovative energy technologies.[22] Table 3 summarizes the comparison of DOE programs supporting CCS.

[21]Federal loan guarantee programs help borrowers obtain access to credit with more favorable terms than they may otherwise obtain in private lending markets because the federal government guarantees to pay lenders if the borrowers default, which makes extending credit more attractive to lenders.

[22]GAO, *Department of Energy: New Loan Guarantee Program Should Complete Activities Necessary for Effective and Accountable Program Management*, GAO-08-750 (Washington, D.C.: July 7, 2008).

Table 3: DOE Programs Supporting Carbon Capture and Storage

	Restructured FutureGen	Clean Coal Power Initiative (Round III)	Regional Carbon Sequestration Partnerships
Description	Demonstration of capture and storage of CO_2.	Demonstration of capture and storage, or beneficial reuse, of CO_2.	Demonstration of CO_2 storage in geologic formations.
Integrates all key CCS components[a]	Yes	Yes	No[b]
Commercial site	Yes	Yes	No
Demonstration or R&D	Demonstration	Demonstration	R&D
DOE cost share	50%[c]	50%[c]	80%[d]
Carbon storage required (amount and location)	Yes, storage required. At least 1 million metric tons/year of CO_2 must be stored in a saline formation and any excess of 1 million metric tons/year can be put to beneficial reuse, such as for enhanced oil recovery.	No, storage not required. 300,000 metric tons/year can either be stored or put to beneficial reuse, such as for enhanced oil recovery.	Yes, storage required. Some will store up to 1 million metric tons/year in geologic formations.

Innovations for Existing Plants Program	Advanced Turbines Program	Advanced Integrated Gasification Combined Cycle Program	Loan Guarantees (Round III)
Develops CO_2 capture and compression technologies for pulverized coal power plants, which represent the majority of existing coal plants.	Creation of new turbines for IGCC plants that will include CCS and facilitate near-zero atmospheric emissions.	Supports the development of advanced gasification technologies to enable CO_2 capture with minimal impact on the cost of electricity.	Loan guarantees for activities at retrofitted and new facilities that incorporate carbon capture and sequestration, other beneficial uses of carbon, or advanced coal gasification.
No	No	No	Possible
No	No	No	Yes
R&D	R&D	R&D	n/a
80%	80%	80%	n/a
n/a	n/a	n/a	n/a

Source: GAO analysis of DOE program documents.

[a]Key components include capture, compression, transport, storage and measurement, monitoring and verification.

[b]The Regional Partnerships will conduct large-scale geological sequestration testing that will require the participants to secure sufficient quantities of CO_2 needed to demonstrate CO_2 storage, monitoring, and verification. However, while DOE will cost share in the acquisition of CO_2, it will not fund the development and/or testing of CO_2 capture technologies under the Regional Partnership program.

[c]DOE cost sharing is generally capped at 50 percent. According to DOE officials, it is quite common under DOE's commercial demonstration programs for the Government cost share to be well below 50 percent of the total project cost.

[d]DOE cost sharing is generally capped at 80 percent. Private sector cost sharing under the seven Regional Partnerships averages 34 percent.

DOE Did Not Support Its Decision to Restructure FutureGen with Sufficient Information on Costs, Benefits, or Risks

According to our recent work and best practices, a decision to terminate or significantly restructure an ongoing program should typically be informed by timely and sufficient information on the costs, benefits, and risks of such a decision. While DOE had reason to be concerned about the escalating costs of the original FutureGen, it made its decision to cancel that program and replace it with the restructured FutureGen based, in large part, on a comparison of cost estimates that were not comparable. That is, it compared one estimate that was in current dollars with one that was in constant dollars. In restructuring FutureGen, DOE did not sufficiently analyze the costs, benefits, and risks of canceling the original FutureGen and replacing it with a significantly restructured program. A comprehensive analysis could have helped DOE determine how the costs, benefits, and risks of the restructured FutureGen compared with those of the original FutureGen. Because it did not conduct such an analysis, DOE cannot be assured that the restructured program is the best option to accelerate the widespread commercial advancement of CCS more quickly than the original program. Other options, rather than dramatically restructuring the program, were possible that could have preserved some of the benefits of the original program, including ensuring the integration of IGCC and CCS at the FutureGen facility. For example, FE identified and analyzed 13 other options for incremental, cost-saving changes to the original program, such as reducing the CO_2 capture requirement. While FE did not consider all of these options to be viable, it recommended or noted several of them for consideration with potential savings from $30 million to $55 million each.

DOE Decided to Restructure FutureGen Based, in Large Part, on a Comparison of Cost Estimates that Were Not Comparable

In January 2007, as part of its initial conceptual design report for the original FutureGen, the Alliance estimated the cost of the original program at about $1.8 billion. The Alliance's report explained that this estimate included inflation through 2017—the last year of the anticipated life of the program—and was the equivalent of almost $1.4 billion in constant 2006 dollars. This report also stated that, after subtracting anticipated revenue from program activities, such as the sale of electricity, the estimate was similar to DOE's 2004 estimate of $950 million. However, DOE officials told us that DOE's estimate did not subtract anticipated revenue. In March 2007, after approving the Alliance's cost estimate, DOE renewed the cooperative agreement with the Alliance to proceed with developing a preliminary design for FutureGen by June 2008, including a revised cost estimate and a risk analysis. The preliminary design was to be based on a specific site and technology for the program—information that has an important impact on the program's overall cost because labor expenses vary from location to location, and technology costs and designs, such as for turbines, vary depending on the specific manufacturer and vendor.

The March 2007 renewed cooperative agreement listed approximately $1.8 billion as the current estimated cost of the project. However, senior DOE officials soon began to express concerns about escalating program costs, and they directed FE officials to develop recommendations for controlling costs. In September 2007, FE officials presented several recommendations for incremental changes to control costs to the Deputy Secretary of Energy; they also noted various measures already in place for controlling costs, such as monthly progress reports and a risk management program. Importantly, none of the recommendations indicated that DOE should cancel the original program and restructure FutureGen; moreover, FE officials told us that they did not prepare any analysis or recommendations for senior DOE officials that resembled what was to become the restructured program.

According to DOE, following this presentation, senior DOE officials directed FE to negotiate with the Alliance new cost sharing arrangements under the cooperative agreement, which was scheduled for continuation in June 2008. The Alliance agreed to meet to renegotiate the terms of the cooperative agreement. Over the course of several meetings, the parties discussed various funding scenarios and exchanged proposed term sheets. Subsequently, however, the Alliance and DOE did not reach agreement. In December 2007, the Alliance sent a letter to DOE stating that it preferred to proceed under the existing cooperative agreement until FutureGen's costs and risks could be assessed with input from the preliminary design report and cost estimate that were due by June 2008.

Also in December 2007, the Secretary of Energy briefed senior presidential advisers that the estimated cost of FutureGen had nearly doubled—from $950 million to $1.8 billion—and that costs were expected to continue rising. In addition, according to the briefing documents, DOE planned to end its partnership with the Alliance and was developing a new strategy for FutureGen that would cap the government's financial exposure. The briefing documents explained that DOE's new approach for FutureGen would fund only the CCS-related technology associated with multiple commercial IGCC plants, rather than the entire construction of a single plant with CCS. Around this time, according to DOE officials, senior DOE officials directed FE to develop the restructured FutureGen program. In response, these officials told us, many high-level offices within DOE collaborated on developing a draft strategic planning document for the restructured program. According to these officials, the draft strategic planning document that they finalized in January 2008 was the first complete document about the restructured FutureGen. On January 30, 2008, DOE publicly announced that it was restructuring FutureGen to provide a ceiling on federal contributions and that the restructured program was a more cost-effective approach. On this same day, DOE notified the Alliance that it was restructuring FutureGen and would not continue its cooperative agreement with the Alliance. DOE informed the Alliance that it was restructuring FutureGen in response to serious concerns over substantial escalation in projected costs, including what the agency concluded would be the likely continued escalation of the costs. DOE officials also stated that they disapproved of the Alliance's decision to announce the selection of a project site before DOE issued its NEPA Record of Decision. According to DOE, prior to the site selection announcement and without knowledge of the Alliance's choice of site, DOE had asked the Alliance not to go forward with the announcement and further advised the Alliance against making an announcement until the Record of Decision had been issued. DOE officials also said that, in their negotiations on measures that could limit DOE's financial exposure, they lost confidence in the ability of the Alliance to fund its share of the project cost.

Although comparing cost estimates can provide valuable insight about the impact of escalating costs on a project, DOE based its decision to restructure FutureGen, in large part, on a comparison of cost estimates that were not actually comparable. That is, in 2004, DOE had estimated that the cost of the original FutureGen would be $950 million in constant 2004 dollars. In contrast, the Alliance's 2007 estimate of about $1.8 billion was in current dollars, which reflected inflation over the course of the program from 2005 through 2017.[illegible] In explaining his decision to restructure FutureGen to senior presidential advisers, the Secretary of Energy indicated that the projected program costs had "nearly doubled," from $950 million to $1.8 billion. However, comparing constant dollars, which exclude inflation, with current dollars, which reflect inflation, is misleading. Our calculations show that the Alliance's current dollar estimate of roughly $1.8 billion is equivalent to approximately $1.3 billion

[illegible]The Alliance estimate was $1.785 billion, in current dollars, from 2005 through 2017.

in constant 2005 dollars—an increase in total program costs of about $370 million, or about 39 percent—not a near doubling of costs.[24]

In addition, the cost estimates by DOE and the Alliance were prepared early in the project and, as a result, were based on conceptual designs for FutureGen, including power plant case studies and a blanket 10 percent increase incorporated into the Alliance's estimate to allow for the first-of-a-kind nature of some of the plant's components and integration issues. However, neither estimate considered costs for specific types of technology or a specific location. If DOE had waited approximately 6 months for the Alliance's technology-specific and site-specific cost estimate, due by June 2008 as part of its preliminary design report, before deciding whether to restructure the program, it would have had the benefit of more current and complete information, including the latest information on escalating costs, when making decisions about how to move forward with FutureGen.[25] In addition, regarding FutureGen's total cost, the March 2007 cooperative agreement stated that DOE and the Alliance recognized that many uncertainties—such as plant design, site selection, and market conditions—still existed in developing a firm cost estimate.[26]

In May 2008, the Secretary of Energy testified before Congress that FutureGen was conceived as a $950 million venture and that its estimated cost had increased to roughly $1.8 billion; however, the Secretary's

[24]We selected constant fiscal year 2005 dollars for illustrative purposes. However, our review of DOE's documentation pertaining to its $950 million cost estimate for the original FutureGen shows that DOE considered base year constant dollars for the estimate from several years, ranging from late quarter 2003 dollars, to fiscal year 2004 dollars, and fiscal year 2005 dollars. We asked DOE to confirm the base year for its cost estimate, and department officials responded that several versions of the estimate had been prepared using fiscal year 2003 and fiscal year 2004 dollars. When we pointed out the existence of an additional estimate in fiscal year 2005 dollars, DOE officials informed us that they would clarify which constant year dollars DOE had used. However, as of January, 2009, DOE had not yet fully clarified this information for us.

[25]The Alliance has decided to continue preparing the preliminary cost estimate, and it anticipates completing and releasing the estimate by early 2009.

[26]The cooperative agreement also stated that DOE and the Alliance agreed in principle to, ultimately, cap DOE's share of costs at $700 million in constant 2004 dollars—approximately 74 percent of DOE's cost estimate—and it required the Alliance to develop, by June 2008, a proposal for the terms of such a cap. The cap was to be adjusted for unanticipated cost escalation upon each scheduled renewal or continuation of the cooperative agreement, based on a suitable index of actual costs negotiated by DOE and the Alliance.

prepared statement did not indicate that the first estimate was in constant dollars, while the second was in current dollars.[27] The Secretary also testified that DOE believed its costs would continue to escalate. We requested that DOE provide us with the analysis that supported DOE's anticipated escalation. In October 2008, DOE officials told us that the ongoing cost escalations were unprecedented and that they had looked internally across various indexes, including the Bureau of Labor Statistics, to get a sense of prospective escalation. However, they stated that they did not have any written or comprehensive analysis. They added that they did not prepare a position paper, study, or generate any analysis examining current or future escalation for the decision to restructure FutureGen. Moreover, economic forecasting organizations, such as DOE's Energy Information Administration, have found that significant cost escalations, such as those for building power plants over the past several years, do not typically continue in the long run.[28]

A Comprehensive Analysis Could Have Helped DOE Determine How the Costs, Benefits, and Risks of the Restructured FutureGen Compared with Those of Other Options

DOE did not prepare a comprehensive analysis comparing the relative costs, benefits, and risks of the original and restructured FutureGen programs before making the decision to replace the original program with the restructured FutureGen. On two different occasions, DOE officials told us that the agency did not prepare such an analysis. These officials told us that the Secretary of Energy's May 2008 congressional testimony included the agency's official explanation for why it decided to restructure FutureGen. In September 2008, we asked DOE to provide us with additional information, including the agency's official position on why it decided to restructure FutureGen, all the factors upon which DOE based the decision, the extent to which the decision was based on documented supporting analysis, and a copy of any such analysis. In January 2009, after we sent a draft of this report to DOE for review and comment, DOE responded to our request for additional information, stating that the detailed analysis supporting its decision to restructure FutureGen could be found in the draft strategic planning document for the restructured program and that this document discussed the factors considered by DOE in making the decision to restructure FutureGen. However, as previously

[27] U.S. Senate, Committee on Appropriations, Testimony of Samuel W. Bodman, Secretary of Energy, U.S. Department of Energy, before the Subcommittee on Energy and Water Development, May 8, 2008.

[28] These findings are for building power plants, in general, and do not specifically address FutureGen.

discussed in our findings, the draft strategic planning document was not completed in time to inform the decision to restructure FutureGen. In addition, we do not consider the draft strategic planning document to be comprehensive because it did not assess:

1. whether costs for the original FutureGen would escalate substantially in the future;
2. the relative costs, benefits, and risks for all of the types of plants for which the restructured FutureGen was eligible to receive proposals, such as conventional pulverized-coal and oxyfuel combustion plants, but only contemplated proposals for IGCC plants;
3. the risk that industry respondents might not propose an IGCC plant for the restructured FutureGen;
4. the risk that industry respondents might not propose enough viable projects for the restructured FutureGen;
5. the costs, benefits, and risks of making incremental changes to the original FutureGen alongside the relative costs, benefits, and risks of the restructured FutureGen; and
6. any potential overlap between the restructured FutureGen and other DOE programs.

A comprehensive analysis could have supported DOE's decision making in several ways. First, it could have helped DOE assess the risk that industry respondents to DOE's request for applications under the restructured FutureGen might not propose an IGCC plant. DOE received public comments indicating that such an outcome was possible because IGCC is not yet prevalent in the industry—only two commercial IGCC plants currently operate in the United States—and other technologies may provide better opportunities to meet the restructured program's requirements, among other reasons. Applying CCS at existing, conventional pulverized coal-fired plants is important because those plants comprise almost all operating coal-fired plants in the United States and abroad. However, according to DOE, IGCC plants integrated with CCS are important for reducing CO_2 emissions in the future. Both DOE's press release announcing the restructured program and the updated draft strategic planning document, dated July 1, 2008, that DOE provided Congress indicated that the restructured program would include IGCC. The funding announcement for the restructured FutureGen highlighted the important contribution that an IGCC plant integrated with CCS would make toward the nation's energy needs, such as providing continued fuel diversity for generating electricity and mitigating dependence on more expensive and less secure sources of energy. As late as May 2008, the Secretary of Energy indicated in congressional testimony that the restructured program would likely include IGCC, stating that advances in technology and the market, in addition to regulatory uncertainty, would provide incentives for industry to begin deploying commercial-scale IGCC plants with CCS.

In addition, a comprehensive analysis could have helped DOE assess the risk that industry respondents might not propose enough viable projects from which DOE could then assess and make multiple selections. Such an analysis could also have helped DOE assess whether the new cost-share arrangement would provide sufficient incentive for enough proposals to be selective. In the draft planning documents and press release announcing the restructured program, DOE stated that it restructured FutureGen, in part, because market conditions had changed in such a way that DOE could fund multiple industry projects and accomplish even more widespread commercialization of CCS and related information sharing across the industry than what would have been accomplished by the Alliance's consortium of 11 coal producers and electric power companies. However, DOE only received a small number of applications and some proposed projects were outside the restructured FutureGen's scope. As a result, widespread commercialization and information sharing seem less likely than under the original program. DOE also asserted that the restructured program would hasten the time frame for full-scale commercial operation of CCS. However, even if DOE accepts all applicable applications, the restructured program could implement CCS sooner than the original program at only a few commercial sites rather than, as stated before, on a more widespread and international scale.

Finally, DOE also could have used a comprehensive analysis to help compare the relative costs, benefits, and risks of the restructured FutureGen with those of making incremental and other changes to the original program in order to control or offset costs. For example, prior to the decision to restructure FutureGen, FE identified and analyzed 13 options for changes to the original program, such as reducing the CO_2 capture requirement, which aimed at reducing costs while continuing to retain some of the original program's key benefits. DOE noted that some of the potential changes would have a detrimental impact on the original program's objectives, while other potential changes would not significantly impact project objectives. Of these changes, FE either recommended or noted that DOE should be willing to consider several options with potential savings from $30 million to $55 million each. Some of these scenarios were broached during negotiations with the Alliance in the fall of 2007.

Conclusions

According to DOE, electric power industry, academic, and other officials and experts, for the foreseeable future, coal, which is abundant and relatively inexpensive, will remain a significant fuel for the generation of electric power in the United States and the world. However, coal-fired power plants are also a significant source of CO_2 and other emissions responsible for climate change. Hence, for at least the near-term, any government policies that seriously address climate change will need to have a goal of significantly reducing CO_2 and other emissions from coal-fired power plants. CCS, while still in its infancy, can be a promising technology to achieve these purposes. By integrating IGCC and CCS technology at a living laboratory host facility, DOE's FutureGen program was intended to address significant technological, cost, and regulatory issues associated with the implementation of CCS at a new plant. However, in early 2008, citing concerns about a "doubling of costs," DOE abruptly canceled the original FutureGen program and announced a dramatic restructuring. The restructuring cast aside the initial concept and substituted a request for multiple projects to be proposed by industry that would retain the goal of capturing and sequestering 1 million metric tons of CO_2, and would accept technologies other than IGCC. The restructured FutureGen left open the possibility of successfully applying CCS technology to existing conventional, pulverized coal-fired power plants—an important goal in its own right, since those plants account for almost all of the coal-fired generating capacity in the United States and abroad. However, there are already existing programs to address CCS at existing plants, and the decision to remove the FutureGen program's specific focus on cutting edge technology (IGCC) at new plants was not well explained.

In at least two ways, DOE's decision, which affected potentially up to $1.3 billion in federal funding, was not well considered. First, the decision was made on the basis of a flawed comparison of life-cycle costs for the original FutureGen, in that DOE compared an estimate of constant dollars to an estimate of inflated dollars. Second, the decision was not based on a systematic and comprehensive comparison of the costs, benefits, and risks of the original FutureGen versus the restructured FutureGen. An expanded analysis of the costs, benefits, and risks of the original FutureGen compared with a range of modifications to the program could have included incremental changes to the original FutureGen program that could have preserved some of its original goals and benefits while mitigating costs. Such an analysis might also have detailed the risk that DOE would receive only a small number of applications and that those applications might not include IGCC. The analysis could also have considered whether DOE's $1.3 billion contribution for total program funding presents the best option for advancing the overall goals of CCS in both existing and future plants.

Recommendations for Executive Action

To help ensure that important decisions about the FutureGen program reflect an adequate knowledge of the potential costs, benefits, and risks of viable options, and to promote the attainment of the goals of the program while protecting taxpayer interests, we are making the following two recommendations to the Secretary of Energy:

1. Before implementing significant changes to FutureGen or before obligating additional funds for such purposes, the Secretary of Energy should direct DOE staff to prepare a comprehensive analysis that compares the relative costs, benefits, and risks of a range of options that includes (1) the original FutureGen program, (2) incremental changes to the original program, and (3) the restructured FutureGen program.

2. In addition, the Secretary should consider the results of the comprehensive analysis and base any decisions that would alter the original FutureGen on the most advantageous mix of costs, benefits, and risks resulting from implementing a combination of the options that have been evaluated.

Agency Comments and Our Evaluation

We provided a draft of this report to the Secretary of Energy for review and comment. DOE did not comment on the recommendations and conclusions of the report; however, it provided technical and clarifying comments, most of which we have incorporated, as appropriate. For example, we revised the report to reflect DOE's comment that it had reached its decision to restructure FutureGen, based on concerns about increasing costs associated with constructing the original FutureGen project and that it had attempted to negotiate a more favorable cost sharing agreement with the Alliance. However, DOE added that it had stopped those negotiations because it believed that the Alliance would not be able to financially partner with DOE to complete the project. We also revised the report to reflect information provided by DOE about the role of IGCC in the original and restructured FutureGen efforts, the type of knowledge likely to be disseminated by the original and restructured FutureGen efforts, and budget and appropriation data for FutureGen, beginning in fiscal year 2004. DOE's comments are reprinted in appendix III, along with our responses.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the Secretary of Energy, the DOE Office of the Inspector General, and interested congressional committees. This report also will be available at no charge at GAO's Web site at http://www.gao.gov.

If you or your staffs have any questions about this report, please contact me at (202) 512-3841 or gaffiganm@gao.gov. Contact points for our Office of Congressional Relations and our Office of Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix IV.

Mark C. Gaffigan

Mark Gaffigan
Director, Natural Resources and Environment

Appendix I: Scope and Methodology

We examined (1) the goals of the original and restructured FutureGen programs, (2) the similarities and differences between the restructured FutureGen and other Department of Energy (DOE) carbon capture and storage programs, and (3) the extent to which DOE used sufficient information to support its decision to restructure the FutureGen program.

To examine the goals of the original and restructured FutureGen programs, including the results of the different approaches for meeting these goals, we reviewed relevant appropriations and agency documents, including budget justifications from fiscal years 2005 through 2009; the program plan for FutureGen that DOE submitted to Congress in 2004; the cooperative agreement between DOE and the FutureGen Industrial Alliance (Alliance), and its subsequent renewals; DOE's draft strategic planning documents and funding announcement for the restructured program; and public responses to DOE's request for information about the restructured FutureGen and its funding announcement. We also reviewed congressional testimony about FutureGen and related topics by officials from the Alliance; DOE, including the Secretary of Energy; and other knowledgeable stakeholders, such as academic and industry researchers. In addition, we met with and reviewed documents provided by officials and researchers from DOE, the Alliance, industry, nonprofit research organizations, and academia. In particular, we interviewed DOE officials from the Office of Fossil Energy's (FE) National Energy Technology Laboratory (NETL) and Office of Clean Coal. Finally, we conducted semi-structured interviews with knowledgeable stakeholders from the electric power and coal industries, nonprofit research organizations, and academia, among others. During the interviews, we discussed the goals, approaches, and anticipated results of the original and restructured FutureGen programs. Our method for conducting these interviews, including how we selected the knowledgeable stakeholders, appears in the next paragraph.

We conducted semi-structured interviews with 14 knowledgeable stakeholders from the electric power and coal industries, nonprofit research organizations, and academia, among others. We selected a nonprobability sample of stakeholders and stakeholder organizations using a "snowball sampling" technique, whereby each stakeholder we interviewed identified additional stakeholders and stakeholder organizations for us to contact.[1] Specifically, we identified the first three stakeholders to interview from previous, related GAO work and a group of contributors toward key scientific assessments of climate change and clean coal technology.[2] We then used feedback from these interviews to identify additional stakeholders to interview, and so on, being certain to interview every stakeholder or a knowledgeable official from every stakeholder organization identified by at least two other stakeholders. We also ensured that we selected stakeholders from electric power companies both within and outside the Alliance to obtain a range of industry perspectives. Over the course of our work, we conducted semi-structured interviews with knowledgeable stakeholders from the following organizations: American Electric Power, Carnegie Mellon University, the Coal Utilization Research Council, Duke Energy, Duke University, the Electric Power Research Institute, the Massachusetts Institute of Technology, the National Association of Regulatory Utility Commissioners, the National Mining Association, Resources for the Future, and Southern Company. We used a semi-structured interview guide to interview these stakeholders and facilitate analysis of what they identified as the key similarities, benefits, and differences between the original and restructured FutureGen programs, in addition to DOE's other carbon capture and storage (CCS) programs. These semi-structured interviews allowed us to obtain information addressing all three of our objectives.

To examine the similarities and differences between the restructured FutureGen and other DOE CCS programs, we reviewed agency documents, including budget justifications from fiscal years 2005 through 2009; DOE's Carbon Sequestration Technology Roadmap and Program

[1]The information gathered from these semi-structured interviews cannot be used to generalize findings to, or make inferences about, the entire population of knowledgeable stakeholders on FutureGen and clean coal technology. Although the sample provides some variety, it is unlikely to capture the full variability of knowledgeable stakeholders and it cannot provide comprehensive insight into the views of any one group of knowledgeable stakeholders. This is because, in a nonprobability sample, some elements of the population being interviewed have no chance, or an unknown chance, of being selected as part of the sample. However, the information gathered during these semi-structured interviews allows us to discuss various stakeholder views on FutureGen and clean coal technology, and it provides important context overall. It also helps us interpret the documentation and testimonial evidence we have collected.

[2]Massachusetts Institute of Technology, *The Future of Coal: Options for a Carbon-Constrained World* (Cambridge, MA, 2007) and IPCC, *IPCC Special Report on Carbon Dioxide Capture and Storage* (Montreal, Canada, Sept. 2005).

Plan; the program plan for FutureGen that DOE submitted to Congress in 2004; DOE's draft strategic planning documents and funding announcement for the restructured program; and relevant laws. We met with and discussed these programs with officials from NETL and FE's Office of Clean Coal. We also conducted semi-structured interviews with knowledgeable stakeholders from the electric power and coal industries, nonprofit research organizations, and academia, among others. During these interviews, we discussed the relationship between the restructured FutureGen and DOE's other CCS programs. Finally, we reviewed public responses to DOE's request for information about the restructured FutureGen and DOE's funding announcements for the restructured FutureGen and Round III of the Clean Coal Power Initiative.

To examine the extent to which DOE used sufficient information to support its decision to restructure the FutureGen program, we reviewed documents from DOE and the Alliance, including cost estimates; the cooperative agreement and subsequent updates to it; letters, presentations, and proposals documenting the renegotiation of terms for the cooperative agreement; proposed incremental changes for controlling costs; and the draft strategic planning documents and funding announcement for the restructured program. We also reviewed congressional testimony about FutureGen and related topics by officials from the Alliance; DOE, including the Secretary of Energy; and other knowledgeable stakeholders, such as academic and industry researchers. We met with and discussed the information used to support the decision to restructure FutureGen with officials from NETL and FE's Office of Clean Coal. In addition, we discussed and reviewed analyses of the costs for building coal-fired, electric power plants with officials and researchers from industry, academia, and government, including DOE's Energy Information Administration. Moreover, we discussed these costs during semi-structured interviews with knowledgeable stakeholders from the electric power and coal industries, nonprofit research organizations, and academia, among others. We also reviewed public responses to DOE's request for information about the restructured FutureGen and its funding announcement. Finally, we reviewed our recent work and guidance on best practices for cost estimation, program management, and programmatic decision making, as well as guidance from DOE and the Office of Management and Budget.

We conducted this performance audit from June 2008 to February 2009, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Budget Authority and Obligations for FutureGen

Table 4: DOE Budget Authority and Obligations for FutureGen, Fiscal Years 2004 through 2008

Dollars in millions

Fiscal year	DOE budget authority for FutureGen	Adjusted DOE budgetary resources	DOE obligations for its cooperative agreement with the FutureGen Industrial Alliance	Remaining budgetary resources
2004	$9	$8.64		
2005	$18	$17.26		
2006	$18	$17.33		
2007	$54	$52.50		
2008	$75	$74.32		
Total	**$174**[a]	**$170.05**[b]	**$39.11**[c]	**$130.94**[d,e]

Source: DOE

[a]All FutureGen budget authority was no-year authority, which means the authority is available for obligation for an indefinite time period. DOE has requested $156 million for FutureGen in its budget justification for fiscal year 2009.

[b]According to DOE, the department adjusted its program budget for several factors. In fiscal years 2004 through 2008, the program's budget authority was adjusted for the Small Business Innovation Research program and/or the Small Business TechnologyTransfer program. Moreover, the FutureGen budget for fiscal years 2004 and 2005 also included the Interior and Omnibus reduction, and in fiscal years 2004 and 2006, FutureGen's budget authority included a general rescission.

[c]According to DOE, the agency has spent over $22 million on obligations for the original FutureGen, via its cooperative agreement with the FutureGen Industrial Alliance. In addition, DOE anticipates reserving an additional $2.5 million for final close-out costs related to these obligations pending invoicing from the Alliance. Depending on the actual amount of these final close-out costs, DOE estimates that it could deobligate approximately $14.5 million of its obligations for the original FutureGen, after which time these funds would be available for the restructured FutureGen.

[d]According to DOE, the agency has additional obligations and expenditures for support contracts related to FutureGen that fall outside the scope of its cooperative agreement with the Alliance. The expenditures and remaining obligations for these contracts total approximately $7.8 million.

[e]DOE officials told us that, after accounting for all anticipated expenditures on the original FutureGen, they expect the agency to have approximately $293 million available for the restructured FutureGen in unobligated balances of unexpired budget authority, brought forward from prior years (i.e., carryover), including the $156 million budget request for fiscal year 2009.

Appendix III: Comments from the Department of Energy

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

Department of Energy
Washington, DC 20585

February 4, 2009

Mr. Mark E. Gaffigan
Director
Natural Resources and Environment Team
U.S. Government Accountability Office
441 G Street, NW, Mail 2T23A
Washington, DC 20548

Dear Mr. Gaffigan:

Thank you for the opportunity to review the Government Accountability Office (GAO) draft report entitled, "DOE's Decision to Restructure FutureGen Should Be Based on a Comprehensive Analysis of Costs, Benefits, and Risks" (GAO-09-248). Enclosed please find the U.S. Department of Energy's comments on the draft report.

If you have any questions or comments please contact Mr. Jarad Daniels of my staff at (202) 485-7355.

Sincerely,

Victor K. Der
Acting Assistant Secretary
Office of Fossil Energy

Enclosure:
DOE Comments on Draft GAO Report

Department of Energy Comments on GAO "DOE's Decision to Restructure FutureGen Should be Based on a Comprehensive Analysis of Costs, Benefits, and Risks" (GAO-09-248) (GAO Draft Report)

This responds to your request for comments by the Department of Energy on the above-referenced GAO Draft Report.

See comment 1.
Now on pp. 8 and 24.

1. The draft report uses inconsistent terminology to characterize the 13 options for incremental changes developed by the Office of Fossil Energy. The summary page, page 9, and the discussion on page 27 make it appear that all 13 options were viable without jeopardizing the project objective. In reality, some of the 13 options were not considered viable or recommended by Fossil Energy and were rejected by the Department as a whole.

At each of these locations (the summary page, last sentence of the third paragraph; page 9, the first full sentence; and page 27 second to last sentence of the first paragraph), DOE recommends GAO delete the number "13." Not all of the 13 options would have preserved the original project objectives nor were all recommended. Additionally on page 27, the last sentence of the first paragraph is incorrect and should either be deleted or the sentence should start with "Some of these options."

The discussion on page 33 is more accurate in that it states that DOE considered some of the potential changes within the list of 13 to have a detrimental impact on the original project objectives and pursued the remaining changes during negotiations with the Alliance. To the extent GAO believes discussion of the FE options is appropriate, DOE recommends that the report consistently present the options as they are characterized on page 33.

See comment 2.
Now on pp. 2, 17, and 18.

2. On page two, suggest that the last sentence of the carryover paragraph be changed to reflect that only Round III of the CCPI focused on carbon capture and sequestration and that selections have not yet been made. Suggested revision would read:

> *For example, DOE's Clean Coal Power Initiative (CCPI) Round III Funding Opportunity Announcement will result in cost-shared partnerships with industry for projects that demonstrate carbon capture from coal-fired plants with sequestration or beneficial reuse.*

See comment 3.
Now on pp. 3 and 26.

3. On page 3, in the first full paragraph, the draft report states:

> *In December 2007, after DOE finished conducting the extensive environmental analyses required by the National Environmental Policy Act of 1969… of four potential sites that took over a year, the Alliance announced that it had selected Mattoon, Illinois, for the location of FutureGen.*

1

In order to accurately depict the context of activities at the time, the report text should be revised. The above-quoted sentence implies that DOE completed its NEPA responsibilities prior to the Alliance announcement of the Mattoon site, and that is not the case. For projects requiring an environmental impact statement, an agency's NEPA review culminates with a Record of Decision. DOE had not issued a Record of Decision at the time the Alliance, over the Department's objection, chose to announce its site selection. The chronology of activities set out in the Cooperative Agreement clearly provided for the issuance of a Record of Decision first. This context should be provided for in the text of the GAO report.

See comment 4.
Now footnote 5.

4. On page 4, DOE recommends changing footnote 4 to read:

> *In addition, for original FutureGen, costs for the initial planning and research stages were subject to a 20 percent nonfederal cost-share.*

As drafted by GAO, the footnote sentence applies to both the original and restructured approaches, but should only apply to the original FutureGen. For Restructured FutureGen, DOE mandated not less than 50 percent private sector cost-share for all stages.

Since Fiscal Year 2005, the requirements for cost sharing of the original FutureGen has been set out in statute:

> *Provided further, That the initial planning and research stages of the FutureGen project shall include a matching requirement from non- Federal sources of at least 20 percent of the costs: Provided further, That any demonstration component of such project shall require a matching requirement from non-Federal sources of at least 50 percent of the costs of the component . . .*

See, e.g., Pub. L. No. 108-447.

See comment 5.

5. On pages 6 and 18, the draft report suggests that the technology transfer potential was greater under the original FutureGen because the non-profit Alliance would own new inventions and was willing to share its knowledge industry-wide. GAO contrasts the original FutureGen with the Restructured program where GAO believes for-profit recipients would be more reluctant to disseminate information. In fact, the intellectual property policies and provisions for each effort are essentially the same. For both the original and Restructured program, most new inventions would likely be generated by for-profit subcontractor/vendors supplying technology to the project. Ownership of these inventions would be granted to the subcontractors/vendors either by law for small businesses or nonprofits, or through a DOE patent waiver for large businesses. Inventions by the Alliance were far less likely since they were to have subcontracted for most technology development efforts. Furthermore, as with original FutureGen, DOE will require Restructured FutureGen recipients to disseminate the results of the project. Accordingly, the underlying assumptions for GAO's conclusions and comparisons about

2

technology transfer potential are in part faulty. Please see DOE's comments on GAO's draft statement of facts.

In the same section on page 6, and in the first line on page 19, the draft reports states that the Alliance was comprised of utilities, mining companies, and "others." To the best of DOE's knowledge, the Alliance was comprised only of utilities and mining companies both domestic and foreign.

See comment 6.

6. In the first line on page 8, CO_2 should have a subscript rather than a superscript.

See comment 7.
Now on pp. 3 and 26.

7. On page 13 in the first paragraph, the draft report states:

> *On January 30, 2008, about a month after the Alliance announced that it had selected Mattoon, Illinois, for the site of the FutureGen plant, DOE announced that it had decided to take the FutureGen program in a different direction.*

We believe the statement set out above needs to be put in context. Prior to the announcement and without knowledge of the Alliance's choice of site, DOE asked the Alliance not to go forward with an announcement and further advised the Alliance that an announcement at that time was inadvisable in light of the ongoing DOE-Alliance discussions.

By mid-2007, in part because of an overall climate of cost escalations for building power plants around the world, DOE managers had become increasingly concerned about actual and potential escalating costs for FutureGen, and DOE had signaled to the FutureGen Alliance that DOE had serious concerns about the sustainability of the project. During September 2007, DOE began negotiating with the Alliance to develop a mutually acceptable cost-sharing formula to deal with the prospect of further cost-growth.

In December 2007, after analyzing four potential sites for the original FutureGen, the FutureGen Alliance announced that it had selected Mattoon, Illinois, for the location of the original FutureGen. The Alliance announced the site in advance to DOE's issuance of a record of decision (ROD) to complete DOE's review under the National Environmental Policy Act (NEPA) and contrary to DOE's advice. Announcement of the Alliance's selection of a site prior to the ROD was inconsistent with the schedule set out in the Cooperative Agreement.

Only after months of unsuccessful negotiations with the FutureGen Alliance regarding cost sharing for cost growth did DOE announce, on January 30, 2008, that it would not proceed beyond the then current budget period with the FutureGen Alliance, and that it planned to take a different approach to FutureGen. DOE's rationale for this decision was based on DOE's interest in maximizing the role of private sector innovation, providing a ceiling on federal contributions, and accelerating and increasing the use of clean energy technologies to help meet the growing demand for energy while also mitigating greenhouse gas emissions. The selected location of the site had no bearing on DOE's determination.

See comment 8.
Now on p. 14.

8. On page 16, the first sentence of the first full paragraph states:

> *Both the original and restructured programs would operate plants at commercial size (about 300 megawatts).*

Under the restructured program, IGCC plants were expected to have a nominal capacity of 300 megawatts, but, as set out in the Funding Opportunity Announcement, non-IGCC projects needed only to be at a scale sufficient to prove commercial viability and be designed to produce and capture 1 million tons of CO_2 per year.

See comment 9.
Now on p. 15.

9. On page 17, in Table 2, under original FutureGen, the word "includes" should be deleted in the first row since the original program was exclusively focused on IGCC.

See comment 10.

10. On page 19, DOE recommends GAO strike the words "in new inventions it would likely own" from the last sentence of the first paragraph. Inclusion of this phrase would actually limit the scope which can also more broadly include non-patentable technical data.

See comment 11.
See comment 2.
Now on pp. 2, 17, and 18.

11. On page 21, the words "Round III" should be added after "Clean Coal Power Initiative" in the underlined heading since only the third round of CCPI has focused on carbon sequestration.

See comment 12.
Now on p. 23.

12. On page 25, change footnote "d" to read "DOE cost sharing is generally capped at 80 percent." Alternately, delete the first sentence of the footnote.

See comment 13.
Now on p. 25.

13. On page 28, DOE recommends that GAO revise the first sentence of the last paragraph to read:

> *Following this presentation, senior DOE officials directed FE to negotiate with the Alliance new cost sharing arrangements under the cooperative agreement, which was subject to a continuation decision in June 2008.*

See comment 14.

14. On page 29, in the fourth to last sentence of the first full paragraph, DOE recommends that GAO replace the word "renewing" with "continuing" for technical accuracy.

See comment 15.
Now on p. 26.

15. On page 29, the second to last sentence of the first full paragraph, as currently drafted, erroneously suggests that DOE officials disapproved of the selection of Mattoon for the project site. The sentence implies that DOE's determination was influenced by the Alliance's selection of the Mattoon site, and that is not the case. Prior to the announcement and without knowledge of the Alliance's choice of site, DOE asked the Alliance not to go forward with an announcement and further advised the Alliance that an

4

announcement was inadvisable. The selected location of the site had no bearing on DOE's determination to restructure the program.

DOE recommends that the second to last sentence of the first full paragraph be revised into two sentences as follows:

> *DOE officials also stated that they disapproved of the Alliance's decision to announce the selection of a project site. Prior to the announcement and without knowledge of the Alliance's choice of site, DOE asked the Alliance not to go forward with an announcement and further advised the Alliance that an announcement was inadvisable. DOE had not issued its NEPA Record of Decision and was continuing its attempts to negotiate with the Alliance.*

See comment 16.
Now on p. 26.

16. On page 29, the sentence at the end of the first paragraph should be modified to make it clear that DOE lost confidence in the ability of the Alliance to fund its share of the project cost, rather than confidence in the Alliance member companies or their representatives.

See comment 17.
Now on p. 29.

17. On page 32, the third to last sentence of the first paragraph suggests that the draft strategic planning document was developed in July 2008, and that is not correct. The document was transmitted to Congress in response to a document request in July of 2008. In addition, we would also like to clarify a point regarding DOE's position on the role of CCS, including IGCC with CCS, in reducing CO_2 in the future. Therefore the sentence should be changed to read as follows:

> *However, according to DOE, plants with CCS, including those with IGCC integrated with CCS, are important options for reducing CO_2 emissions in the future, and DOE's press release announcing the restructured program and the draft strategic planning document that DOE provided to Congress in July 2008 indicated that the restructured program would include IGCC.*

See comment 18.
Now on pp. 28, 29, and 38.

18. On page 32, footnote 30 and on page 40, table II.2 footnotes b and c, the draft report states: "DOE had not yet provided" the information or response that GAO had requested. As of the date of these comments, DOE understands that it has either already provided the relevant documentation, and has referred GAO back to those documents, or has since provided the documentation. DOE understands that all information has been provided.

See comment 19.
Now on p. 38.

19. On page 40, we noticed several errors in the Tables contained in Appendix II.
Table II.1

The correct FutureGen appropriations for Fiscal Year 2004 through 2008 are as follows:

2004	$9,000,000
2005	$18,000,000
2006	$18,000,000
2007	$54,000,000

5

Total $174,000,000

These above-stated amounts are not yet adjusted for rescissions or the SBIR/STTR offset. Hence, the actual amount available to DOE for FutureGen, as depicted in Table II.2, is less than $174,000,000. Under the "Appropriated" column in Table II.1, the Fiscal Year 2007 amount should be changed from $18,000,000 to $54,000,000. The total should be changed accordingly. Under the heading "Directed" in Table II.1, the Fiscal Year 2007 amount of $257,000,000 should be deleted as this was deferred budget authority under the Clean Coal Technology Program that was not made available to the Department for FutureGen. The last column should be updated to reflect the changes in the first two columns.

<u>Table II.2</u>

The calculations for the Fiscal Year 2006 Budget are as follows:

Appropriation Act	$18,000,000
General Rescission 1%	(180,000)
SBIR Assessment	(441,000)
STTR Assessment	(53,000)
FY-2006 Available	$17,326,000

The Fiscal Year 2006 amount in Table II.2 should be changed from $17,820,000 to $17,326,000 and the Total changed to $170,045,000.

6

The following are GAO's comments on the Department of Energy's letter dated February 4, 2009.

GAO's Comments

1. We modified our report to address DOE's concerns about our discussion of the 13 options for incremental changes.
2. We modified our report to add clarifying information on Round III of the Clean Coal Power Initiative.
3. We added clarifying information about the timing of the site selection announcement and the release of DOE's NEPA Record of Decision.
4. We revised the footnote to state that, according to DOE, not less than a 50 percent nonfederal cost share will be required for all of the restructured FutureGen's stages.
5. We have revised the report to remove the referenced discussion.
6. We made DOE's editorial correction.
7. The report does not state or imply that the location of the site was the reason for the program's restructuring, but rather states that DOE's restructuring decision was based on a desire to contain costs in a time of increasing cost pressures. However, we revised the report to clarify that the Alliance announced its site selection decision before DOE's Record of Decision was released—which has not happened, as of the date of this report.
8. DOE clarifies that under the restructured program, IGCC plants are expected to have a nominal capacity of 300 megawatts, but non-IGCC projects need only be at a scale sufficient to prove commercial viability and be designed to produce and capture 1 million tons of CO_2 per year. We revised the report to reflect this information.
9. As suggested by DOE, we revised table 2 to reflect that the original FutureGen program focused exclusively on IGCC.
10. As indicated in our response to comment 5, we have revised the report to remove the referenced text.
11. We made appropriate revisions to the report to reflect that Round III of the Clean Coal Power Initiative focuses on carbon sequestration.

12. We revised table note "d" to table 3, to state that DOE's cost sharing is generally capped at 80 percent.

13. We revised the report to clarify that senior DOE officials directed FE to negotiate new cost sharing arrangements under the cooperative agreement with the Alliance.

14. We revised the report to use the word "continue" in place of "renew" wherever it would more accurately reflect the various stages of the cooperative agreement.

15. Our draft report did not insinuate or state that DOE did not favor the Mattoon, Illinois, site or that DOE's restructuring decision was based on a disapproval of the Alliance's site selection announcement. Rather, our report states that DOE's decision was based on a desire to limit its exposure to increased costs. However, as suggested by DOE, we clarified the report by adding that DOE had instructed the Alliance to not announce the site selection before DOE could release the Record of Decision.

16. We agree with DOE and revised the report to clarify that DOE lost confidence in the ability of the Alliance to fund its share of the project cost, rather than that DOE lost confidence in the Alliance members or their representatives.

17. We revised the report to clarify that both DOE's press release announcing the restructured program and the updated draft strategic document, dated July 1, 2008, that DOE provided Congress indicated that the restructured program would include IGCC.

18. DOE provided information regarding the official basis for restructuring the FutureGen program and its budget authority, obligations, and expenditures that we incorporated into our report, including table 4 and its table notes. We also included in the report an additional assessment of documents, to which DOE referred as providing the basis for its decision to restructure FutureGen.

19. Regarding the tables in appendix II of the draft report, DOE provided updated FutureGen appropriations information for fiscal years 2004 and 2007 and certain calculations for the fiscal year 2006 FutureGen budget. In response, we merged tables 4 and 5 from the draft to create one table in the final report, and we adjusted the figures and calculations for the data that DOE provided.

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

Mark Gaffigan, (202) 512-3841 or gaffiganm@gao.gov

Staff Acknowledgments

In addition to the contact named above, Ernie Hazera (Assistant Director), Nancy Crothers, Cindy Gilbert, Chad M. Gorman, Angela Miles, Karen Richey, Michael Sagalow, and Jeanette M. Soares made key contributions to this report. Harold Brumm, Jr., and Timothy Persons also made important contributions.

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BIOGRAPHY FOR MARK GAFFIGAN

Mark Gaffigan is a Director for the U.S. Government Accountability Office's (GAO) Natural Resources and Environment team in Washington, D.C. The GAO is an independent, nonpartisan agency that evaluates and audits the programs and expenditures of the Federal Government. Mr. Gaffigan's current responsibilities include leadership of GAO's work on energy-related issues. Mr. Gaffigan began his career with GAO in 1987 and has worked on a variety of federal program reviews with an emphasis on budget and program reviews of the U.S. Department of Energy. Mr. Gaffigan has a BA in Economics and a MA in Public Administration, and he is also a Certified Public Accountant.

Chair BAIRD. Mr. Gaffigan, thank you. I want to take this opportunity to acknowledge we have been joined by Chairman Gordon, Chairman of the Full Committee. Mr. Chairman, good to see you. Thanks for being here and for your request for this hearing as well.

Also, Mr. Luján, Dr. Lipinski, Ms. Edwards, Mr. Chandler, and Ms. Johnson are also here as well.

Dr. Finley.

STATEMENT OF DR. ROBERT J. FINLEY, DIRECTOR, ENERGY AND EARTH RESOURCES CENTER, ILLINOIS STATE GEOLOGICAL SURVEY

Dr. FINLEY. Mr. Chairman and Members of the Committee, I appreciate the opportunity to appear before you today and offer comments on carbon sequestration.

Understanding the capacity to geologically sequester carbon dioxide produced as a byproduct of fossil fuel and biofuel use is an essential strategy to mitigate climate change related to the buildup of greenhouse gases in the atmosphere. In 2007, the Fourth Assessment Report of the Intergovernmental Panel on Climate Change stated that "carbon capture and storage in underground geological formations is a new technology with the potential to make an important contribution to mitigation by 2030. Technical, economic and regulatory developments will affect the actual contribution." At the Illinois State Geological Survey, a unit of the University of Illinois, we have been investigating carbon sequestration technology since 2003 as part of a U.S. Department of Energy Regional Carbon Sequestration Partnership. Our Partnership, the Midwest Geological Sequestration Consortium covers the Illinois Basin, a 60,000 square-mile area that covers most of Illinois, southwestern Indiana, and western Kentucky. Our Phase I Characterization effort, from 2003 to 2005, focused on compiling existing information. Our Phase II validation effort currently underway involves multiple small-scale, field pilot injection projects. Most importantly, we are now engaged in a critical Phase III deployment effort, the Illinois Basin-Decatur test site, that will offer significant advances in carbon sequestration technology.

After two years of site-specific planning and development and planning at a site in Decatur, Illinois, we began on February 14 of this year the drilling of a 7,500 feet deep injection well that will receive 1,000 metric tons per day of CO_2. As of this morning, we were drilling below 3,546 feet. This is the first Phase III deployment well in the Nation drilled as part of the DOE regional carbon sequestration partnership program. We will be injecting over three years to meet an injection goal of one million metric tons. The permit is held by the Archer Daniels Midland Company, who has provided a half-square mile site, logistical and engineering support, and will provide the CO_2 as a product of their fuel ethanol production operations.

We are confident that our work over the preceding five years and a year-long permitting process has resulted in an exceptional site for deployment phase testing. We have evaluated subsurface rock formations to define the capability of a reservoir to hold carbon dioxide, and we have defined multiple thick and competent reservoir seals, and we have demonstrated that there are no detectable faults and fractures that could serve as leakage pathways back to the surface.

As a climate change mitigation strategy, the CO_2 must remain in place and not leak back to the atmosphere, not contaminate potable ground water, not affect surface biota, and not present a risk to human health and safety. This implies that we must do an excellent job of investigating the site. We have been carrying out environmental site monitoring since mid-2008. Before CO_2 is ever injected, we will have more than a year of background data on groundwater chemistry, soil gas composition, plant stress assessed through color infrared aerial imagery, and atmospheric monitoring. We have 12 groundwater wells over the projected area of the subsurface plume and beyond. We will conduct more geophysical studies that will show us in three dimensions where in the reservoir rock the CO_2 is actually located. Most importantly, we will drill two additional 7,500 feet deep observation wells within the half-square mile area of the plume to calibrate these geophysical studies. These same wells will also serve as early warnings of any failure of our primary reservoir seal, an outcome with very low probability but one that we nevertheless must demonstrate is not taking place.

In conclusion, well characterized sites with appropriate geology and careful monitoring can make a contribution and, in fact, must be part of a portfolio response to dealing with carbon dioxide emissions. In our regional partnership, we have a comprehensive research agenda that we believe will show that geological sequestration can be scaled up to be a safe and effective tool to combat climate change. Further, we are working to ensure that we share our results with research consortia around the world. A State Department-World Resources Institute delegation of university researchers and corporate officials from China visited the Illinois Basin-Decatur drill site two weeks ago, and we will make a reciprocal visit to China this coming June. Next week, I will present our partnership results at a meeting of the CO_2Geonet European Research Network in Italy.

While there is more yet to do in understanding the contributions that geological carbon sequestration can make at large scales in combating climate change, and more of these efforts will indeed take place as a result of the provisions of the *Recovery and Reinvestment Act,* I believe we are now moving at an accelerating pace to develop the technology and to share it around the world for our common benefit. Thank you.

[The prepared statement of Dr. Finley follows:]

PREPARED STATEMENT OF ROBERT J. FINLEY

Mr. Chairman, Members of the Committee, I appreciate the opportunity to appear before you today to offer comments on carbon sequestration. Understanding the capacity to geologically sequester carbon dioxide (CO_2) produced as a byproduct of fossil fuel use, including the use of advanced coal technologies, is an essential strategy to mitigate climate change related to the buildup of greenhouse gases in the atmosphere. In 2007, the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) stated that "carbon capture and storage in underground geological formations is a new technology with the potential to make an important contribution to mitigation by 2030. Technical, economic and regulatory developments will affect the actual contribution." At the Illinois State Geological Survey, a unit of the University of Illinois, we have been investigating sequestration technology since 2003 as part of a U.S. Department of Energy (DOE) Regional Carbon Sequestration Partnership. Our Partnership, the Midwest Geological Sequestration Consortium (MGSC), covers the Illinois Basin, a 60,000 sq. mi., geological feature that extends beneath most of Illinois, southwestern Indiana, and western Kentucky. Our Phase I Characterization effort, 2003–2005 focused on compiling existing information that, when evaluated, indicated the Illinois Basin has suitable geology for geological carbon sequestration. Our Phase II Validation effort, involving multiple small-scale, field pilot injection projects, began in late 2005 and will continue to be carried out through 2009. Most importantly, we are now engaged in a critical Phase III Deployment effort, the Illinois Basin-Decatur test site, that will offer significant advances in geological carbon sequestration technology.

After two years of site-specific planning and development at a site in Decatur, Illinois we began, on February 14, 2009, the drilling of a 7,500 feet deep injection well that will receive 1,000 metric tons per day of CO_2, beginning about this time next year. This is the first Phase III deployment well in the Nation drilled as part of the DOE regional sequestration partnership program and the first well permitted for one million metric tons under existing Class I U.S. EPA Underground Injection Control regulations. We will be injecting over three years to meet our 1 million metric ton objective. The permit is held by the Archer Daniels Midland Company, who has provided a half-square mile site, logistical and engineering support, and will provide the CO_2 from their fuel ethanol production operation. We are confident that our work over the preceding five years and a year-long permitting process has resulted in an exceptional site for Deployment phase testing. We have evaluated subsurface rock formations to define a reservoir to hold the CO_2, defined multiple thick and competent reservoir seals, and demonstrated that there are no detectable faults and fractures that could become leakage pathways. We believe we will be able to show that the sequestration process can be safe and effective.

As a climate change mitigation strategy, the CO_2 must remain in place and not leak back to the atmosphere, not contaminate potable ground water, not affect surface biota, and not present a risk to human health and safety. That implies that we must do an excellent job of investigating the properties of these rocks and the fluids now within them and of predicting their performance in the future. At our Illinois Basin-Decatur site, we have been carrying out environmental monitoring since mid-2008. Before CO_2 is ever injected, we will have more than a year of background data on groundwater chemistry, soil gas composition, plant stress assessed through color infrared imagery, and atmospheric monitoring. We have 12 groundwater wells over the projected area of the subsurface CO_2 plume and beyond. We will conduct more geophysical studies that will show us in three dimensions where within the reservoir rock the CO_2 is actually located. Most importantly, we will drill two additional 7,500 feet deep observation wells within the half-square mile area of the plume to calibrate the geophysical studies and ensure that our understanding of the fate of the CO_2 is as complete as possible. These same wells will also serve as early warnings of any failure of our primary reservoir seal, an outcome with very low probability, but one that we nevertheless must demonstrate is not taking place. We have a comprehensive risk assessment process in place that defines our response to equipment failures, accidents, and geological problems.

Let me conclude with some observations on the process to date. We sometimes read comments that geological carbon sequestration is an untested technology and therefore cannot be part of the global climate change response. I would suggest the opposite: that well characterized sites with appropriate geology and careful monitoring can make a contribution, and, in fact, must be part of a portfolio response to dealing with carbon dioxide emissions. In our regional partnership, the MGSC, we are addressing every element of a comprehensive research agenda that we believe will show that geological carbon sequestration can be scaled up to be a safe and effective tool to combat climate change. Further, we are working to ensure that we share our results with research consortia around the world. A State Department-World Resources Institute delegation of university researchers and corporate officials from China visited the Illinois Basin-Decatur site two weeks ago; we will make a reciprocal visit to China in June. Next week, I will present our partnership results at a meeting of the CO_2Geonet European (research) Network in Italy. While there is more yet to do in understanding the contributions that geological carbon sequestration can make at larger scales in combating climate change, and more of these efforts will take place as a result of the provisions of the *American Recovery and Reinvestment Act,* I believe we are now moving at an accelerating pace to develop this technology and to share it around the world for our common benefit. Thank you for the opportunity to be here this morning.

BIOGRAPHY FOR ROBERT J. FINLEY

Robert J. Finley is the Director of the Energy and Earth Resources Center at the Illinois State Geological Survey, Champaign, Illinois. He joined the Illinois Survey in February 2000 after serving as Associate Director at the Bureau of Economic Geology, The University of Texas at Austin. Rob's area of specialization is fossil energy resources and geological carbon sequestration. His work has ranged from large-scale resource assessment, addressing hydrocarbon resources at national and State scales, to evaluation of specific fields and reservoirs for coal, oil, natural gas, and carbon dioxide storage. He is currently heading the Midwest Geological Sequestration Consortium, a U.S. Department of Energy regional carbon sequestration partnership in the Illinois Basin aimed at addressing approaches to geological carbon management. Rob has served on committees of the National Petroleum Council, the American Association of Petroleum Geologists, the National Research Council, the Stanford Energy Modeling Forum, and the U.S. Potential Gas Committee. He has taught aspects of energy resource development since 1986 to numerous clients domestically and overseas in Venezuela, Brazil, South Africa, and Australia, among other countries. Rob holds a Ph.D. in geology from the University of South Carolina. He is currently also an Adjunct Professor in the Department of Geology, University of Illinois at Urbana-Champaign.

Chair BAIRD. Thank you, Dr. Finley. Mr. Monroe.

STATEMENT OF MR. LARRY S. MONROE, SENIOR RESEARCH CONSULTANT; MANAGER, ENGINEERING SCIENCE AND TECHNOLOGY, SOUTHERN COMPANY, BIRMINGHAM, ALABAMA

Mr. MONROE. Mr. Chairman, Members of the Subcommittee, thank you for the opportunity to speak to you today about Southern Company's activities and plans for advanced coal technologies.

Southern Company is a vertically integrated utility serving over four million customers in the southeast. We are one of the largest electricity generators in the United States, with some 70 percent of our energy coming from coal.

I am a manager of engineering science and technology for Southern Company. I have been researching emissions control for coal-powered plants for over 25 years. Southern Company has a long history of cooperative work for the U.S. Department of Energy in development of technologies for the utility industry, including work on selective catalytic reduction for NO_X emissions from gas scrubbers for sulfur oxide emission and mercury-control technologies.

As we face a future with policies that would limit emissions of carbon dioxide, we believe that coal must continue to play a role. Further, we believe that coal can and must play a role going forward with constraints on carbon emissions. To achieve this goal, technologies are currently being developed and adapted from other industries to capture and store emissions of CO_2. However, the technologies are not yet ready for utilities to use commercially. They are not yet proven in power plant service, and as of today, they are too costly. This is the issue going forward. How can these technologies be proven and the cost reduced to make them commercially viable in the future?

Southern Company is active in developing and demonstrating advanced coal technology to meet this large challenge. First I will talk about our sequestration efforts.

As a charter member of the Southeast Regional Carbon Sequestration Partnership or SECARB, Southern Company has co-funded its activities and served as a host for a Phase II project injecting 3,000 tons of CO_2 under one of our power plants in southeast Mississippi. Working further with SECARB, we have a goal to scale up to a Phase III sequestration project of 100,000 tons of CO_2 per year in similar geology at another one of our Gulf Coast power plants. This proposed project would feature a 25-megawatt scale CO_2 capture plant that would be built to supply the CO_2 for the sequestration demonstration. We have a further goal of developing an even larger scale-up of the sequestration project that would feature injection of one million tons of CO_2 per year for five years into the saline reservoirs of the Gulf Coast Region. This project would include the 170-megawatt capture plant to supply the CO_2. We submitted this proposed project in response to both the restructured FutureGen solicitation as well as CCPI Round III.

Now you will notice that both of these two steps in sequestration scale-up are planned to also demonstrate CO_2 capture at increasing scale on conventional coal power plants.

For IGCC, we have asked the Mississippi Public Service Commission for approval to build a 600-megawatt IGCC power plant in eastern Mississippi using local lignite coal and design for 50 percent CO_2 capture. The CO_2 would be sequestered and enhanced oil recovery operations in Mississippi oil fields. This new power plant would be partially funded with DOE funds from CCPI round two and with investment tax credits authorized by the *Energy Policy Act of 2005.* Also in partnership with the DOE, Southern Company operates a research station in Wilsonville, Alabama, focused on developing advanced power generating technologies, including fundamental R&D for coal gasification. It is now moving its focus toward basic R&D and scale-up of technologies to capture CO_2 from both conventional and IGCC coal plants.

You can see the Southern Company is working on four areas we believe to be important: large-scale sequestration tests, CO_2 capture from conventional coal plants, IGCC plants with carbon capture, and fundamental R&D for next generation technologies. The issues to be overcome for widespread commercial deployment of carbon capture and sequestration are cost and timing. Both the pilot and industrial-scale trials of CO_2 capture systems are much more expensive to build and operate than technologies for NO_X, SO_2, or mercury. The same high-cost penalties apply to full-scale power plants. To address high cost, we strongly think that a robust program of both technology development and a program of basic R&D are needed. Many of the Nation's scientists are only now turning their attention to this field, and breakthroughs are possible. As for timing, the issue is the need to demonstrate to various stakeholders the effectiveness and safety of geological sequestration. As MIT recommends, we think it is necessary for the Nation to have multiple, large-scale sequestration demonstrations of over one million tons of CO_2 per year for at least five years. In order to have these results in adequate time, these demonstrations need to be started as soon as possible.

Working in partnership with the U.S. DOE and others, Southern Company looks forward to working on the challenge of capturing CO_2 from coal plants and demonstrating geological sequestration of CO_2.

[The prepared statement of Mr. Monroe follows:]

PREPARED STATEMENT OF LARRY S. MONROE

Summary

Southern Company is active in developing and demonstrating advanced coal technologies. As a charter member of the Southeast Regional Carbon Sequestration Partnership (SECARB), Southern has co-funded SECARB's activities, as well as serving as a host site for a Phase II sequestration project injecting 3,000 tons into a saline reservoir at one of our power plants in southeast Mississippi. With SECARB, we have a goal to scale up to a sequestration project of 100,000 to 150,000 tons CO_2 per year into similar geology at another of our Gulf Coast power plants. This project would feature a 25 MWe scale CO_2 capture plant built by Southern Company and research partners to supply the CO_2 for the sequestration project.

Southern Company has a further goal of developing a larger scale up of this sequestration project that would feature one million tons CO_2 per year for at least five years into the saline reservoirs of the Gulf Coast region. Building on the results of the smaller demonstration, this project would include a 170 MWe CO_2 capture plant to supply the CO_2 for the sequestration project. This proposed project was submitted by Southern Company in response to both the Restructured FutureGen solicitation as well as the CCPI Round 3 solicitation. Southern Company will likely resubmit this project to CCPI 3 when it is reopened later this year.

Southern Company's Mississippi Power affiliate has asked the Mississippi Public Service Commission for approval to build a 600 MWe (net) IGCC power plant using native lignite and designed for 50 percent CO_2 capture from startup. The captured CO_2 would be sequestered in EOR operations in Mississippi oil fields. This new power plant is partially funded with DOE funds from CCPI Round 2 and with investment tax credits authorized by the *Energy Policy Act of 2005*.

In partnership with the DOE, Southern Company operates a research station in Wilsonville, Alabama, that has focused on advanced power generating technologies, including fundamental R&D for coal gasification, and is now moving its focus towards fundamental R&D and scale up for technologies to capture CO_2 from both conventional combustion coal plants and IGCC plants.

The barriers to widespread commercial deployment for CCS are mostly cost and timing. Both the pilot and industrial scale trials of CO_2 capture systems are much more expensive to build and operate than the technologies that have been tested and developed for control of other emissions like NO_x, SO_2, or mercury. The same high cost penalties apply to current CO_2 capture and sequestration approaches for full scale power plants. Therefore, both a robust program of technology development and a program of fundamental R&D are needed. Many of the Nation's scientists are only just now turning their attention to this field and breakthroughs are possible. New science, teamed with scale up and demonstration programs will help bring forward affordable and effective CCS technologies.

A parallel barrier to widespread deployment of CCS is the need to demonstrate to various stakeholders the effectiveness and safety of geological sequestration. To get to that point, it is necessary for the Nation to have multiple concurrent large scale sequestration demonstrations of over one million tons CO_2 per year for at least five years in duration. In order to have these results in adequate time, these demonstrations need to be started as soon as possible.

Working in partnership with the U.S. DOE, vendors, and other utilities, Southern Company looks forward to the challenge of developing, demonstrating, and improving technologies to capture CO_2 from coal-based power plants and towards demonstrating the effectiveness of geological sequestration of CO_2.

Introduction

Chairman Baird, Ranking Member Inglis, and Members of the Subcommittee, thank you for the opportunity to speak with you today about Southern Company's activities and plans for developing and demonstrating advanced coal technologies.

Southern Company is a super regional energy company serving customers in Alabama, Florida, Georgia, and Mississippi. Southern Company is the one of the largest generators of electricity in the United States with 42,000 megawatts of generating capacity and over 21,000 megawatts of it is coal-fired. I hold a Ph.D. in Chemical Engineering from MIT, and have been involved in research on pollution control for coal-based power plants for over 25 years in university, not-for-profit research institute, and corporate settings. At Southern Company, I have two roles: I support our technology research organization as a senior research consultant and I also support our gasification and carbon capture research station as the Manager of Engineering Science and Technology. With these efforts, I am deeply involved with the development and demonstration of advanced ways of using coal to generate electricity.

Southern Company has a long history of cooperative work with the U.S. Department of Energy in development of technologies for the utility industry, including work on low NO_x burners and selective catalytic reduction (SCR) systems for NO_x emissions reductions, flue gas de-sulfurization (FGD) systems for sulfur oxides reductions, mercury control technologies to reduce mercury emissions, and various others.

As we face a future with possible legislation and/or regulations that would limit emissions of greenhouse gases, including carbon dioxide (CO_2), we believe that coal must continue to play a role in the energy future of the country. It currently represents 50 percent of the electricity generated in the Nation today and it's ample and relatively low cost domestic supply means it must continue to power our homes, businesses, and industries in the future. We believe however that coal can and must play a role in a future with constraints on carbon emissions. Technologies are currently being developed and adapted from other industries to capture and store emissions of CO_2 from coal power plants to achieve this goal. However, the technologies are not yet ready for the utility sector to use in a commercial way - they are not yet proven in utility service and as of today, they are too costly in both capital and operating expenses. This is the issue going forward, how can these technologies (or new ones not yet invented) be proven and the costs reduced to make them commercially viable in the future for which they will be needed?

1.0 Development of Technology for the Utility Industry for Carbon Capture and Storage (CCS)

The lack of large scale storage of electricity means that technologies for generating electricity must be proven and robust in order to maintain the reliability and stability of the electric grid. Generation must meet demand and the industry cannot test new technologies at full scale without assurance that it will not threaten operations and reliability. For this reason, the utility industry has learned that new technologies and processes must be developed and proven in a series of tests that start at small sizes and move to progressively larger sizes before they can be relied upon at a full scale generating plant. It is typical for new utility technologies to take four or five demonstration steps and between seven to fifteen years of development time to prove that they are adequate, robust, affordable, and reliable.

The development path of technologies to capture and store carbon dioxide (CO_2) emissions from coal-based power plants will follow a similar path. Given that regulatory or legislative efforts to limit CO_2 emissions from power plants are active, there is a pressing need to develop technologies that can be used in coal-based electricity generation and simultaneously achieve the environmental, economic, and operational requirements. Carbon capture and sequestration (CCS) for coal-based power plants is really a series of four steps: (1) capturing the CO_2 from the power plant, (2) compressing the CO_2 to the pressure required for pipeline transport, (3) transporting the CO_2 through a pipeline to the sequestration field, and (4) injecting the CO_2 deep underground into stable geological structures (sequestration).

CO_2 capture is a technology and cost challenge; processes in the chemical and petroleum industries have been developed to capture CO_2 from similar streams, although not with some of the particular difficulties nor the scale facing large central station power plants. Additionally, the costs of these capture processes at the scale of utility power plants is very high. Current capture technologies can add 30 to 85 percent to the cost of electricity from the plant. The main issue is the amount of heat required to operate the capture plant which can mean a loss of 20 to 25 percent of the electrical output from a plant where this technology is added. Integrated Gasification Combined Cycle (IGCC) plants, where coal is gasified and burned in a combustion turbine—steam turbine combination, offer some promise that the CO_2 can be captured from the synthetic gas (syngas) before combustion. This presents advantages because the CO_2 is at higher concentrations in the syngas and it is already at pressure and therefore may require less of the compression energy described next. However, the vast majority of existing plants are conventional coal combustion units, with only two operational IGCC plants in the entire U.S.

Compression of the CO_2 can be accomplished with available technologies, although the compression costs can amount to 10 percent of the power plant electrical output. (For the steam requirements for capture and the energy for compression of the CO_2, this could total some 30–35 percent of the energy output of the plant to operate with 90 percent CO_2 capture.) For new conventional coal plants with CCS, it is possible to integrate the compression into the steam cycle of the plant and some efficiency improvements can be made.

Pipeline transport of CO_2 to sequestration sites is a conventional technology available today—the U.S. has over 3,600 miles of CO_2 pipelines to move the gas from natural and industrial sources to oil fields for enhanced oil recovery (EOR). CO_2 is used to pressurize oil fields and the CO_2 dissolves into the crude oil making it easier to flow out of the underground reservoir. Pipeline issues for large scale CCS are mainly associated with the expected difficulty in siting and acquiring property for pipeline routes. It has been estimated that a pipeline network equal to one-third of the size of the existing natural gas pipeline network would be needed to capture CO_2 from the existing coal fired fleet in the U.S. (MIT's *"The Future of Coal"* states that if all of the coal power plant carbon emissions are captured and transported by pipeline, the CO_2 moved would be equal to three times the weight of the annual natural gas delivered by the U.S. pipeline system, but only one-third of its volume.)

The most challenging aspect of developing CCS for the utility industry is sequestration. The technology for injecting CO_2 underground for EOR is well-developed and the history of EOR operations indicates that sequestration can be accomplished in a safe and secure manner. However, the scale and potential widespread location of sequestration sites for utility capture of CO_2 will require that sequestration tests be made at sufficient scale for multi-year periods to demonstrate to stakeholders including the general public, regulators, utilities, insurance companies, and financial entities, that it is safe and effective. MIT, in their *"The Future of Coal"* report, states that "we believe high priority should be given to a program that will demonstrate CO_2 sequestration at a scale of one million tons CO_2 per year in several geologies." They further recommend "a minimum of three projects . . . of the order of one million tons CO_2/year for a minimum of five years." Unfortunately, it is not possible to accelerate the timescales for sequestration tests, so it is necessary to start these projects as soon as possible. Because we need to study the movement of CO_2 in the underground structure, there are no good technical ways to make it move faster without disrupting the test. In other words, the spread of the CO_2 will be predicted with models at the beginning of injection, and the goal of these sequestration tests is to see if the spread of injected CO_2 matches the model predictions in both distance and time to get there.

2.0 Accelerated Technology Development for Utility CCS

As described above, the normal technology path for new technology development in the utility industry is to proceed from an invention or development in the laboratory, to a small pilot-scale test, to a larger pilot-scale test for a longer time period, to industrial scale (normally five to ten percent of large full-scale utility plants), and finally to the first operational utility plant. Each of these steps would normally take on the order of one to three years, with the whole process, assuming success at every step, taking a total time of anywhere from seven to fifteen years. It is also typical that several different technology approaches proceed through these steps simultaneously as competitive solutions to a given problem. For Southern Company, the time from our initial pilot-scale work on SCR in a DOE Clean Coal project to our first commercial unit was over six years, and it took 11 years before our first large scale power plant SCR retrofit was operational. A similar timeline for Southern Company's FGD installations, and is holding true for mercury control technology. Our first test of an activated carbon injection into a baghouse for mercury control occurred around 1998 at a pilot scale unit of one MW, followed by a DOE sponsored test at 135 MW starting in 2001, and finally to our first full scale project (880 MW) which started at the end of 2008, a period of 10 years.

We believe that the timeline for the development and demonstration of technologies for the capture of CO_2 and the demonstration of sequestration must be compressed to the maximum extent practicable. A combination of parallel development steps (as compared to the normal sequential steps described above) for CO_2 capture will have to be undertaken to accelerate the technology development. Larger demonstrations will need to be initiated before the smaller scale tests have been completed.

It is also necessary to start large scale sequestration injection tests as soon as possible to be able to demonstrate the ability of this approach to sequester large amounts of CO_2 in a safe, effective, and cost effective manner. Ironically, a current complication of attempting to perform large sequestration projects is the relative scarcity of CO_2 for these tests. There are currently no large scale capture plants in the utility industry to supply the needed CO_2, and most natural and industrial sources are already in use for the food industry and EOR. Therefore, it becomes necessary to build CO_2 capture plants in order to obtain the gas to start these sequestration tests.

3.0 Southern Company's Activities on CCS Technology

Southern Company is active in all of these areas of technology development for CCS advancement. We are a charter member of the Department of Energy's regional partnership for our service territory, the Southeast Regional Carbon Sequestration Partnership (SECARB). The SECARB partnership covers an eleven-state region including the States of Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia. Southern Company has been a funding member of SECARB, and has participated as a host site for a Phase II injection project, and a potential host site for a Phase III injection project. (The seven Regional Partnerships for carbon sequestration were established with funding by DOE to help develop and demonstrate the technology, equipment, and regulations to implement large-scale CO_2 sequestration in various regions and geologies across the U.S.)

Through SECARB, Southern Company's Plant Daniel in southern Mississippi served as the site for injection of 3,000 tons of CO_2 into a saline formation at a depth of about 8,500 feet below ground level. The purpose of this project was simply to test the deep saline reservoirs located near the large coal power plants along the Gulf Coast for geological sequestration of CO_2. This very successful test has led to SECARB being awarded DOE funding for a larger Phase III project to inject 100,000 to 150,000 tons CO_2 per year into similar geological formations at a Southern Company plant located elsewhere on the Gulf Coast. As mentioned above, a real difficulty in performing these sequestration tests is the availability (and cost) of CO_2 for the injection. For the smaller injection of 3,000 tons, the CO_2 was contributed by Denbury Resources who use naturally occurring CO_2 for EOR activities. However, for the larger SECARB Phase III injection program, that amount of CO_2 is not available.

To advance this larger scale sequestration project and to obtain the needed CO_2, Southern Company has established a goal to design, construct, and operate an industrial scale CO_2 capture process at the generating plant site integrated with a sequestration test. (Southern Company has not determined the actual plant site for such a test, but it would be on the Gulf Coast). Through partnerships with EPRI and other utilities, Southern Company's goal is to work towards retrofitting this capture plant for partial capture with one of the leading technologies for CO_2 capture from conventional coal plants. The costs of this capture plant would be borne by these private entities. As indicated above, the estimated costs of CO_2 capture for projected full-scale installations are high in capital and operating costs, and therefore, it is not surprising that pilot and industrial scale test plants are expensive as well. The total project costs for the 25 MWe capture plant to supply the CO_2 for the Phase III sequestration project of 100,000 to 150,000 tons CO_2 per year are estimated to be $140M. In the current economic downturn, it has become a difficult challenge to raise the capital for such a large scale demonstration project, and its prospects are currently being evaluated. We are hopeful that these types of large scale advancement projects can proceed, but economic challenges stand to threaten our ability to pay for such capture demonstrations—which would of course limit our ability to test larger scale sequestration such as the SECARB Phase III project.

If this 25 MW demonstration plant can be constructed, then we have a further goal to expand upon this capture and sequestration demonstration with a larger version, designed to reach the MIT goal of one million tons CO_2 per year for at least five years. This proposal would involve building a CO_2 capture plant of about 170 MWe size to capture the needed one million tons per year. Southern Company has applied for federal assistance on this combined project in response to both the Restructured FutureGen solicitation and the Clean Coal Power Initiative Round 3 (CCPI 3). DOE has recently announced the intent to reopen CCPI 3 with additional funding and Southern Company will likely resubmit an updated proposal in response. The total estimated cost of this 170 MW program would be $750M.

Southern Company has also been actively involved in the development of Integrated Gasification Combined Cycle (IGCC) technology. Southern's subsidiary, Mississippi Power is developing a full-scale IGCC power plant of about 600 MWe (net) on native lignite in east central Mississippi, located in Kemper County. Mississippi Power has submitted an application to the Mississippi Public Service Commission for approval and is in the environmental permitting process. This project has received funding from DOE as an award from CCPI Round 2, as well as having qualified for investment tax credits from Section 48A of the *Energy Policy Act of 2005.* This new IGCC will also feature 50 percent CO_2 capture from the startup of the plant, with the captured CO_2 being supplied to the oil fields of Mississippi for EOR. (In addition to EOR recovering more oil from the field, EOR is also a sequestration technology as the CO_2 replaces the oil in the pores of the sandstone, with about half of the CO_2 flood of the oil field remaining underground and therefore being sequestered. The CO_2 remainder is captured and sent underground again for further EOR operations.) The Kemper County project has a projected capital cost estimate of approximately $2.2 billion. The project is expected to utilize DOE CCPI 2 funding of about $270M and investment tax credits up to $133M. Pending approval by the Mississippi Public Service Commission, it is scheduled to come online in late 2013.

Finally, Southern Company has been working in partnership with the U.S. DOE at the Power Systems Development Facility in Wilsonville, Alabama. Originally dedicated to improving technology to advance the efficiency of particulate removal from high pressure, high temperature gases, the facility has been instrumental in developing and proving the IGCC technology that will be used at Kemper County, one that is well-suited to low rank coals which are economically important to the U.S. economy. Continuing this partnership with DOE, the facility will be exploring fundamental technologies that will improve or completely replace the current technologies for capturing CO_2 from both conventional combustion coal power plants as well as IGCC plants. The particular role for the PSDF in carbon capture will be to assist in transitioning promising technologies from their research laboratory size to the power plant size and environment. Southern Company believes strongly that a robust fundamental research and development program and the associated means to scale up promising technologies is vital to success in commercial CCS development and commercial deployment—and the ability to use the U.S. coal reserves as an energy source for the future.

4.0 Challenges Going Forward for CCS

The challenges for CCS going forward are basically cost and timeframes. The costs of pilot and larger scale research programs for CO_2 capture are much higher than the similar research programs for control of other emissions such as nitrogen oxides (NO_x), sulfur oxides (SO_2 and SO_3), and mercury—in fact they appear to be over 10 times the capital and operating costs of these previous efforts. Given current economic conditions, the utility industry has limited ability to self-fund these projects and advance these technologies to get them ready for commercial use.

Commercial CO_2 capture systems using today's technology are very costly, so much so that the future of coal as a base energy source in the utility sector is threatened. The capital costs of a new conventional coal plant with CCS may be as much as 50 percent to 100 percent higher than the same coal power plant without CCS. Operating costs for the energy required for the capture process and CO_2 compression make the plant much less efficient than today's coal plants. For a CO_2 capture plant added to an existing coal power plant, somewhere between 30 and 35 percent of the plant's electrical output would be lost to operate a 90 percent CO_2 capture system. In other words, a large 900 MWe power plant when equipped with a CCS system would become a 650 MWe plant. Other generation—from coal, natural gas, or some other source—would have to be built to make up for this lost generation.

The timeframe issue is mostly centered on sequestration and the need to perform large scale sequestration projects for multiple years to demonstrate the methods, measurements, stability, and safety of this approach. In order to gain acceptance from multiple stakeholders that geological sequestration is commercially viable, it is essential that these large scale sequestration projects be started as soon as possible. Assuming MIT's recommendation of a minimum of five years of testing, a start today would mean it would be mid-2013 at the earliest before long-term decisions on sequestration could be made.

5.0 Next Steps for CCS Technology Development

The steps needed to advance CCS technology and improve its cost and performance are straightforward: (1) a continuation of the historically successful public-private partnerships between the U.S. Department of Energy and the utility industry in demonstrating and improving CCS; (2) a strong focus on performing large scale capture and sequestration projects as soon as possible; and (3) continued focus and funding for fundamental research and development based on cutting-edge science to develop new technologies and improve the costs and performances of existing CCS technologies.

Southern Company looks forward to working with the Department of Energy, vendors, and the domestic and international utility industry to improve and advance CCS.

BIOGRAPHY FOR LARRY S. MONROE

Larry Monroe is a senior research consultant with Research and Environmental Affairs for Southern Company, a leading U.S. producer of electricity. In this position, he is responsible for special projects related to environmental control technologies, technology assessments, carbon capture technologies, and wastewater treatment processes.

Monroe was named Senior Research Consultant in 2007. He also serves as the Manager of the Engineering Science and Technology group at the Power Systems Development Facility in Wilsonville, Alabama. Previously, he served as Program Manager for Research of Technologies to control emissions from Southern's fossil-fired generation fleet. Monroe joined Southern Company in 1998. Prior to that, he held management positions in environmental and energy research at Southern Research Institute, a not-for-profit research organization based in Birmingham, Alabama.

Monroe serves as Co-Chair of the Utility Air Regulatory Group's Control Technology Committee, and he also serves as a Co-Chair of the Integrated Emissions Control research program of the Electric Power Research Institute.

Monroe serves on the Auburn University Chemical Engineering Advisory Council and on the board of directors of the Western Research Institute, based in Laramie, WY.

A native of Pennsylvania, Monroe received a Bachelor's degree in Chemical Engineering from Auburn University and a doctor of philosophy degree in chemical engineering from the Massachusetts Institute of Technology.

Monroe owns a 55-acre farm, on which he currently resides in Blountsville, AL.

Mr. COSTELLO. [Presiding] Does that conclude your testimony, Mr. Monroe?

Mr. MONROE. Yes, I am sorry. Thank you.

Mr. COSTELLO. Ms. Forbes, you are recognized.

STATEMENT OF MS. SARAH M. FORBES, SENIOR ASSOCIATE, CLIMATE AND ENERGY PROGRAM, WORLD RESOURCES INSTITUTE

Ms. FORBES. Good morning and thank you for inviting me to testify today. I am Sarah Forbes, and I lead the CO_2 Capture and Storage work at the World Resources Institute. The World Resources Institute is a non-profit, non-partisan environmental think tank that goes beyond research to provide practical solutions to the world's most urgent environment and development challenges. The World Resources Institute has taken the lead in exploring the challenges, opportunities and state of technical knowledge in the field of carbon capture and storage.

We convened a two year stakeholder process which resulted in the Guidelines for Carbon Dioxide Capture, Transport, and Storage. This report can serve as a benchmark for decision-makers to use in evaluating potential projects.

The key finding of these WRI guidelines was that even though additional research is needed in some areas, there is adequate technical understanding to safely conduct large-scale demonstrations. In fact, many of the remaining questions about CCS technology can only be answered by additional experience with the technology or policy interventions.

Last July, the G8 set a goal of 20 demonstrations globally by 2010. The U.S. Climate Action Partnership, of which WRI is a member, further recommends building at least five CCS projects in the United States by 2015. Achieving these goals in the right time frame is critical to deal with the looming climate challenge but at the same time will require significant investment. There is a need for establishing a clear and robust international financing mechanism to fund these projects globally. To address this need, Congress should consider committing funding for public/private partnership demonstrations in the United States and formally participate in international demonstration efforts. CCS demonstrations will require billions in research funding with estimates at about $1–1.5 billion per project. Funding allocated in the *American Recovery and Reinvestment Act of 2009* is significant but unfortunately still falls short of what will be needed to commercialize CCS technology. A robust funding mechanism and clear plan for collaboration among demonstration projects internationally is critical. It is time to evaluate existing programs for international collaboration in the context of this emerging suite of global demonstration projects and to form formal partnerships with others pursing demonstrations, the U.K., the E.U., China, Canada, and Australia. We also must enhance capacity for CCS demonstrations in China. China's coal-related carbon dioxide emissions are projected to be 51 percent of the world's total by 2030. Although China is actively developing its non-carbon power sources, even rapid growth will not be enough to replace coal. Deployment of CCS in China may be the only way to globally make the needed reductions in carbon dioxide emissions.

China is itself conducting research and quickly moving towards developing and demonstrating CCS technologies. In fact, the Chinese government was among the foreign governments who had pledged to commit funding for the original FutureGen project. Chinese companies and government institutions are also undertaking a CCS research. For example GreenGen, sponsored by China's five largest power companies, will soon build a 200-megawatt integrated gasification combined cycle power plant with CCS in nearby depleted oil fields before 2020. Both PetroChina, China's largest oil company, and Shenhua, its largest coal company, have pilot CCS programs with planned injections.

It would be to the benefit of both the U.S. and China if there were more direct collaboration on CCS demonstrations. To address this need, Congress can commit funding for public-private partnership demonstration projects in the United States and China that would be jointly funded and operated. This will require a serious funding commitment as well as programs that facilitate information sharing on regulatory and policy issues and support for U.S. businesses working internationally.

Examples of programs that would help build increased capacity for CCS in China or other emerging economies include research exchange programs to bring students and faculty from China to see the projects operating in the United States and to study with leading researchers. An effective near-term approach would be to establish a research exchange program for visits to ongoing demonstrations in the United States including the Department of Energy's Regional Carbon Sequestration Partnership Phase III projects. Exchange programs for environmental regulators and policy experts may also prove useful in resolving the legal, regulatory, and social challenges of deploying CCS technology. The Department of State in collaboration with the Department of Energy have implemented successful exchange programs in the past which could be replicated with a focus on CCS technology and policy.

Recently, as Dr. Finley mentioned, with support from the Department of State's Asia Pacific Partnership, Tsinghua University in China has partnered with WRI on an effort to draft a set of guidelines for safe and effective CCS in China, like the report we did for the United States. This work will be influential in developing Chinese CCS regulation and policy.

In conclusion, globally, CCS has progressed to the point of demonstration-readiness, and there is a race under way to see who will build the world's first large-scale integrated demonstration. Increased coordinated international collaborations are essential. We need to specifically partner with emerging economics like China in demonstrating CCS technology through joint public-private partnerships. In these international collaborations, we must seek ways to build capacity and support efforts to develop global policies and environmental regulations that protect human health and ecosystems. This will include coordination and collaboration on demonstration that beings in the planning stages together with projects that build capacity on regulatory and policy issues. Thank you.

[The prepared statement of Ms. Forbes follows:]

PREPARED STATEMENT OF SARAH M. FORBES

Good morning and thank you for inviting me to testify today. I am Sarah Forbes and I lead the CO_2 Capture and Storage (CCS) work at the World Resources Institute. The World Resources Institute is a non-profit, non-partisan environmental think tank that goes beyond research to provide practical solutions to the world's most urgent environment and development challenges. We work in partnership with scientists, businesses, governments, and non-governmental organizations in more than seventy countries to provide information, tools and analysis to address problems like climate change, and the degradation of ecosystems and their capacity to provide for human well-being.

The World Resources Institute (WRI) has taken a lead in exploring the challenges, opportunities and state of technical knowledge in the field of carbon capture and storage. We convened a two year stakeholder process which resulted in the *Guidelines for Carbon Dioxide Capture, Transport, and Storage* (*http://www.wri.org/publication/ccs-guidelines*) published in November 2008 which can serve as a benchmark for decision-makers to use in evaluating potential projects. In developing the Guidelines, WRI brought together a diverse group of more than 80 technical experts including government officials, NGOs, academics and businesses.

Coal use is responsible for over 40 percent of global carbon dioxide emissions.[1] Without significant, deliberate action to reduce these emissions we cannot address climate change. Carbon capture and storage is one of a number of critical technologies coal-burning nations will need to consider and deploy in the coming decades. International collaboration will be essential to moving CCS technology to scale—reducing costs and securing a global response to the climate challenge. In the next five years, we must move from demonstration to deployment.

In this testimony, I will provide an update on some of the key international collaborations on CCS already underway, and offer some ideas for future direction. I would like to make three key points, each of which I will expand on below.

[1] Energy Information Administration. International Energy Outlook, 2008. Figure 76. *http://www.eia.doe.gov/oiaf/ieo/emissions.html*

First, I will describe the urgent need for a global network of CCS demonstrations that includes joint technology development along with collaboration on resolving investment, regulatory, legal and social barriers to CCS deployment.

Second, I will talk specifically about collaboration on CCS with one country—China. I will describe the efforts many countries and businesses are taking to ensure that at least one of the global CCS demonstrations is in China.

Third, I will describe a few of the major international CCS collaborations that are underway and offer suggestions for how these efforts may best complement each other as the technology is demonstrated worldwide.

I will conclude by providing some concrete suggestions for near-term actions that can be taken to enhance collaborations with China and facilitate global deployment of CCS technology.

1. Develop a Global Network of CCS Demonstrations

In technology development there is a period known as the "Valley of Death" where a technology has been proven in the laboratory and at a small scale but has yet to move from a research effort to commercialization. CCS technology has progressed quickly from an idea to a key part in proposed climate change mitigation plans. This progression is partly thanks to the early successes seen in the pilot capture demonstrations and research and commercial projects where CO_2 has been injected at rates up to a million tons per year. Moving the technology forward into commercialization will require integrated capture and storage demonstration at power plant scale. A key finding of the *Guidelines for Carbon Dioxide Capture, Transport, and Storage* (*http://www.wri.org/publication/ccs-guidelines*) was that even though additional research is needed in some areas, there is adequate technical understanding to safely conduct large-scale demonstrations. In fact, many of the remaining questions about CCS technology can only be answered by additional experience with the technology or policy interventions.

Most experts agree that we need between 15 and 20 demonstrations of differing capture and storage configurations globally. Last July, the G8 set a goal of 20 demonstrations announced by 2010.[2] The U.S. Climate Action Partnership, of which WRI is a member, (USCAP)[3] further recommends building at least five projects of CCS enabled coal fueled facilities in the United States by 2015 (see *www.US-CAP.org*).

Achieving these goals in the right time frame is critical to deal with the looming climate challenge but at the same time will require significant investment. There is a need for establishing a clear and robust international financing mechanism to fund these projects globally. It will also require substantial (but not insurmountable) progress on addressing lingering regulatory, investment, legal, and social issues. The global development of environmental regulatory frameworks for CCS, is testament to our readiness to demonstrate the technology. In 2008, regulatory frameworks for CCS were released at the State and federal level in the U.S.[4,5] and Australia[6] and a Directive for CCS, which included environmental regulations, was passed at the European Union[7] level. Global progression towards a common understanding of how to safely implement the technology seems within reach.

This effort of building a global network of CCS demonstrations will require a significant investment and commitment of resources, along with coordination and support from senior government representatives. However, through strong international collaboration each country need not demonstrate the full suite of capture and storage options. For example, when the UK first announced their plans to move forward with a post-combustion CCS demonstration, it was described as being complimentary to the U.S. FutureGen project which was at that time planning to demonstrate at-scale capture with an Integrated Gasification Combined Cycle (IGCC) plant.[8] The

[2] *http://www.enecho.meti.go.jp/topics/g8/g8sta_eng.pdf*

[3] *http://www.us-cap.org/blueprint/index.asp*

[4] Washington State finalized their regulations in June 2008. *http://www.ecy.wa.gov/news/2008news/2008180.html*

[5] U.S. EPA's proposed rule was released in July 2008 *http://www.epa.gov/safewater/uic/pdfs/prefr_uic_co2rule.pdf*

[6] *http://www.environment.gov.au/settlements/industry/ccs/publications/environmental-guidelines.html* and *http://www.environment.gov.au/settlements/industry/ccs/publications/ccs-propertyrights.html*

[7] *http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P6-TA-20080612+0+DOC+XML+V0//EN&language=EN* and *http://europa.eu/rapid/pressReleases Action.do?reference=MEMO/08/798&format=HTML&aged=0&language=EN&guiLanguage=en*

[8] Presentation given at the 2007 Regional Carbon Sequestration Partnerships Annual Review Meeting *http://www.netl.doe.gov/publications/proceedings/07/rcsp/pdfs/Graves%20UK%20CCS%20Activity%20December%202007%20-%20IRG.pdf*

collective group of global demonstrations should include the full suite of different capture configurations and test storage in a variety of geologic settings.

To address this need, Congress can commit funding for public-private partnership demonstration projects in the U.S. and formally participate in international demonstration efforts. CCS demonstrations will require billions in research funding with estimates at about $1–1.5 billion per project. Funding allocated in the *American Recovery and Reinvestment Act of 2009* is important, but still falls short of what will be needed to commercialize CCS technology. A robust funding mechanism and clear plan for collaboration among demonstration projects is critical. One example of such a plan was recently approved by the European Union with funding for demonstrations coming from the proceeds the European Trading Scheme (ETS) and coordination among projects required.[9] The global CCS demonstration network should include collaborative work on not only technology development, but also information-sharing on legal, social and regulatory issues.

2. Enhance Capacity for CCS Demonstration in China

According to the Energy Information Administration, China's coal-related carbon dioxide emissions may grow to 51 percent of the world's total by 2030.[10] With 20 percent of the world's population, China has 14 percent of the world's coal reserves, but less than one percent of the world's oil and gas reserves. While China is actively developing its non-carbon power sources—hydropower, nuclear, and newer alternative energies—rapid growth will still not be enough to replace coal as a core part of its expanding electricity infrastructure. Deployment of CCS in China may be the only way to globally make the needed reductions in carbon dioxide emissions.

China is conducting research and quickly moving towards developing and demonstrating CCS technologies. In fact, the Chinese government was among the foreign governments who had pledged to commit funding for the original FutureGen project.[11] Chinese companies and government institutions are undertaking a CCS research themselves and with a number of international partners. For example:

- The Chinese power industry has several projects focusing on coal gasification. The largest, GreenGen, sponsored by China's five largest power companies, will build a 200 MW integrated gasification combined cycle power plant in the city of Tianjin. Phases two and three of this project plan for CCS in nearby depleted oil fields, with injection planned before 2020. U.S. Peabody Energy is the one international equity partner in this effort.
- China has two major efforts with European collaborators, the UK–China Near-Zero Emissions Coal Project[12] (NZEC) and the **CO**operation **A**ction within CCS **CH**ina-EU[13] (COACH) Project. Both have done a great deal of preparatory and conceptual work on CCS.
- China's Huaneng group built a small carbon capture demonstration plant at Gaobeidian in Beijing with assistance from Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO). Discussions about a second phase are in process.
- Both PetroChina, China's largest oil company, and Shenhua, its largest coal company, have pilot CCS programs.

There is also a realization in China that robust policies and regulations will be needed to ensure that CCS projects are done responsibly. Tsinghua University has partnered with WRI to draft a set of *Guidelines for Safe and Effective CCS in China.* The effort is modeled after the stakeholder process led by WRI in the U.S. where a diverse set of stakeholders together developed a comprehensive set of guidelines for CCS projects (*http://www.wri.org/publication/ccs-guidelines*). Development of a *Guidelines* document that is available in Chinese for potential project operators, financiers, insurers, and legal experts to as a tool in understanding how to conduct CCS projects responsibly will facilitate demonstration of the technology in China. To enable this effort, Tsinghua University and WRI have assembled a steering committee that includes leading CCS experts from China and the United States.

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[9] The EU recently adopted a legal framework for CCS and also provided funding mechanisms through auction allowances and the EU stimulus recovery package *http://www.scotland.gov.uk/Resource/Doc/917/0077923.ppt#303,8,EU Emission Trading System*

[10] Energy Information Administration. International Energy Outlook 2008. *http://www.eia.doe.gov/oiaf/ieo/emissions.html*

[11] China, India, Australia, Japan and South Korea pledged funding for FutureGen *http://www.futuregenalliance.org/costs.stm*

[12] *http://www.nzec.info/en/*

[13] *http://www.co2-coach.com/*

The Chinese members of the steering committee recently traveled to the United States and toured some of the leading CCS research institutions (including the injection well being drilled in Illinois). This effort is being funded with support from the U.S. Department of State under the Asia Pacific Partnership.[14]

It would be to the benefit of both the U.S. and China if there were more direct collaboration on CCS demonstrations. Not only would working together solve technical problems faster, but given the rate at which Chinese companies are moving, the learning would hardly be one way. Jointly-funded and operated demonstrations, that include government funding combined with private-sector investment is an essential next step. This will require a serious funding commitment as well as programs that facilitate information sharing on regulatory and policy issues and support for U.S. businesses working internationally.

Examples of programs that would help build increased capacity for CCS in China or other emerging economies include research exchange programs to bring students and faculty from China to see projects operating in the U.S. and study with leading researchers. An effective near-term approach would be to establish a research exchange program for visits to ongoing demonstrations in the U.S. including the Department of Energy's Regional Sequestration Partnership Phase III projects. Exchange programs for environmental regulators and policy experts may also prove useful in resolving the legal, regulatory, and social challenges of deploying CCS technology. The Department of State in collaboration with the Department of Energy has implemented successful exchange programs in the past which could be replicated with a focus on CCS technology and policy.

3. Key International CCS Collaborations Underway

There are several high-level international CCS efforts underway, along with numerous individual projects like the WRI–Tsinghua University effort I just described. Each of these efforts can play an important role in the development of the technology. Key to successful integration of these efforts will be clarifying the niche each effort is designed to fill, eliminating redundancies, and designing a path for collaboration.

I would like to highlight three key CCS-specific initiatives already underway:

1. The Carbon Sequestration Leadership Forum[15] (CSLF) is a Ministerial-level effort initiated by the U.S. Department of Energy. It has been in place since 2003 and has been influential in collaborations among governments.
2. Australia has recently initiated a Global CCS Institute,[16] for which the Prime Minister has allocated $100M per year for the next 10 years. This institute is designed to focus specifically on collaboration surrounding demonstration projects.
3. The International Energy Agency[17] (IEA) coordinates international research through the IEA GHG Program. IEA Secretariat is also developing an international roadmap for CCS at the request of the G–8. This roadmap is designed to answer the question of whether and how we can achieve the goal of 20 CCS demonstrations announced globally by 2010 and will provide recommendations for better coordination among international collaborations.

As the technology progresses from R&D towards demonstration, these international efforts can provide an avenue for information-sharing at various levels: the CSLF at the ministerial-level, the IEA among government energy departments, and the Global Institute among those running demonstration projects. It is time to evaluate the existing programs in the context of an emerging suite of global demonstration projects and to form formal partnerships with others perusing demonstrations (UK, EU, China, Canada, Australia). Congress might consider commissioning a formal report on international CCS efforts and use the results of it along with the IEA's International CCS Roadmap (expected publication date October 2009)[18] to clarify and formalize the role of the various international CCS organizations that have emerged. Additionally, although the U.S. Department of Energy's Regional Partnership Program has been acknowledged as the "world's most ambitious program"[19] the work is largely unknown in the international community, in

[14] *http://www.asiapacificpartnership.org/*
[15] *http://www.cslforum.org/*
[16] *http://www.pm.gov.au/media/Release/2008/media_release_0484.cfm*
[17] *http://www.iea.org/Textbase/subjectqueries/cdcs.asp*
[18] *http://www.iea.org/textbase/subjectqueries/ccs/ccs_roadmap.asp*
[19] *http://www.netl.doe.gov/publications/press/2008/08019-IEA_Finds_US_CCS_Plans_Ambitious.html*

part because it is difficult for researchers to receive approval to travel internationally on their government grants. A scholarship program for U.S. researchers working on government-funded projects to attend international CCS meetings and present the results of their research may be useful in better communicating the results of leading U.S. research in this area. Such a merit-based program could be managed through the Department of Energy. Formal arrangements to partner with other countries on demonstrations must be established soon.

Conclusions

Unless we act now to aggressively begin to implement a global CCS demonstration program, we will lock in untold additional quantities of CO_2 emissions from non-CCS, coal-fired power plants around the world. Globally, CCS R&D has progressed to the point of demonstration-readiness and there is a race underway to see who will build the world's first large-scale integrated demonstration of capture, transport, and storage along with power production. The global nature of climate change and the urgent need to act now to avoid locking in a high emissions trajectory for the future necessitates increased and coordinated international collaborations. We need to specifically partner with emerging economies on demonstrating CCS technology, through joint public-private partnerships. In these international collaborations we must seek ways to build capacity and support efforts to develop global policies and environmental regulations that protect human health and ecosystems. This will include coordination and collaboration on demonstrations that begins in the planning stages along with projects that build capacity on regulatory and policy issues (like the WRI–Tsinghua APP project).

In my testimony, I have mentioned five specific actions to consider that will help facilitate international collaboration on CCS, which are summarized here:

1. Commit funding for demonstration projects in the U.S. and in China that are geared towards joint technology development; such projects should be public-private partnerships. The global network of demonstrations should include the full suite of capture technology approaches and test storage in a variety of geologic settings.
2. Develop a framework and funding for research exchange programs to bring researchers from other countries to see projects operating in the U.S. and study with leading researchers. The Department of State in collaboration with the Department of Energy has implemented successful exchange programs in the past which could be replicated with a focus on CCS technology and policy.
3. Increase bilateral efforts to facilitate capacity building and information sharing on regulatory and policy issues.
4. Establish formal partnerships with other countries developing CCS demonstration projects (UK, EU, China, and Australia) to facilitate information-sharing and avoid duplication among demonstration efforts. Also, commission a formal report on international CCS efforts and use the results of it and the IEA CCS Roadmap to clarify and formalize the role of the various international CCS organizations that have emerged.
5. Develop a scholarship program for U.S. researchers working on government-funded projects to attend international CCS meetings and present the results of their research. Such a merit-based program could be managed through the Department of Energy.

DISCUSSION

COST ESCALATIONS

Mr. COSTELLO. The Chairman thanks you, Ms. Forbes. Let me begin questioning. I think the Chairman of the Full Committee, Chairman Gordon, stepped out. When he returns, he has questions I know, but let me begin, Mr. Gaffigan, with your testimony, and I think you touched on this but I would like you to elaborate. In your analysis of the restructured FutureGen, did you find that the cost escalation used by the Department of Energy to justify the restructuring and scrapping the initial FutureGen plan to go with a restructured program valid?

Mr. GAFFIGAN. We asked over and over for analysis behind the cost estimate. We found it was pretty much a straightforward 5.2 percent escalation factor. We pointed out that there are others that point out that you're not going to see that sustained growth in escalation factors. And in fact, EIA had pointed that out, that even at the time we were looking at a lot of cost escalations, look at us today in terms of the concerns about whether there is going to be that cost escalation and whether there was going to be jobs for people because the economy was slowing down. So that is the point made. And that in looking at the total number, you know, very well you could see cost escalation, but we did not see any in-depth analysis and we didn't see a good explanation for why they talked about doubling of costs when, in fact, it was comparing some constant dollars to escalated dollars.

Mr. COSTELLO. And that is a very important point in one of our Subcommittee hearings concerning this issue and the cost escalation, the reason used by the Department of Energy to scrap the project. Without question, the cost did increase, but when you look at other projects around the country and look at the cost of building materials, look at the cost of labor, the increases from the time the project was planned and the projected costs were arrived at, they were no different than any other project of that size. Would that be something that you would agree with?

Mr. GAFFIGAN. I would agree with that, and the other thing I would point out is that the Alliance was working on a revised cost estimate based on a specific site. It is important to point out these estimates were very preliminary, but they had targeted to do a cost estimate in June of '08. The question we raised is what was the cost and sort of not waiting to see what that cost estimate would have been. A newer estimate would have reflected the site-specific type activities, and it seemed like it was never considered.

Mr. COSTELLO. And of course, since the decision was made to pull the plug on the initial project as planned, the fact that we have lost time now, that has increased the cost of whatever project that we move forward with. If it is a scaled-back version or if we would go back to the original proposal, we have increased cost because we have lost time and would you agree with that?

Mr. GAFFIGAN. Well, you know, we didn't look at a specific cost estimate relative to that, but I would say there is definitely an opportunity cost of not going forward. That being said, I think it is important to recognize that cost escalation does happen. In the Department of Energy, there is a history of cost escalation. In fact, if cost escalation was the criteria for going forward with projects at the Department of Energy, FutureGen wouldn't be the only one that would have been canceled.

Mr. COSTELLO. I thank you. Dr. Der, let me ask, at the time when the Administration back then made the decision to pull the plug, one of the things that they were attempting to do was to negotiate with the Alliance on cost share, that they wanted the private sector in the Alliance to come up with a higher percentage of the cost of the project than originally proposed. We were told by the Alliance that that was negotiable, that they in fact would sit down and discuss with the Department of Energy a higher cost share. Is that your understanding?

Dr. DER. My understanding was that such discussions were taking place, and it is my understanding also that the Department did not feel that at that time that these were moving forward in a fruitful, sustainable manner as I was told.

Mr. COSTELLO. Just for the record, the Alliance told us just the opposite, that they in fact were willing to negotiate, were willing to increase their cost share, but the Administration and the Department of Energy at the time had basically made the decision that they were going to scrap, pull the plug on their initial concept and were not earnest in trying to negotiate a higher cost share. But the Alliance was willing to increase their cost share.

LESSONS FROM SMALL-SCALE PROJECTS

One other question and then I will ask Chairman Gordon if he has questions. Dr. Finley, what important lessons have been learned from the small-scale field project that the injection project initiated by the consortium and the validation of its efforts?

Dr. FINLEY. Well, I believe what we have been able to show is that the study that was based on existing data from 2003 to 2005 during our Phase I effort, that data were largely validated in the sense that the thickness of the receiving reservoir over a wide area of the Illinois basin is over 1,000 feet thick. That both includes our test sites and it includes the FutureGen site at Decatur, and at the reservoir seal, the geology of that seal looks competent over a wide area of literally thousands of square miles. So what we basically have validated in our efforts is that the geological characteristics of the area of our regional sequestration partnership and because that is coincident with the Mattoon FutureGen site, that geology is very favorable for geological carbon sequestration.

Mr. COSTELLO. Thank you. The Chairman now recognizes the Chairman of the Full Committee, Chairman Gordon.

Chair GORDON. Thank you, Mr. Costello. I know this is an issue that is close to your heart, and this is a very important issue and a very good panel, and I thank you all for being here.

JUSTIFYING RESEARCH FUNDS

Mr. Gaffigan, your report clearly points out that the DOE was comparing two cost estimates that were just not comparable. You know, unfortunately, we have run into this in other types of R&D projects which makes it difficult to go back to the public and say we need more money when these things aren't clear. What should the Department do and what should Congress require them to do to improve this situation?

Mr. GAFFIGAN. Well, you know, contracting in the government and DOE in particular has been an area that we have focused on. In fact, contracting at DOE is considered a high risk for us and particularly in the weapons side of the house, and I think we have identified certain things that are important in terms of controlling costs and managing projects. And it sort of starts at the top, a commitment to schedule, having the right people involved there and contracting the resources, and the commitment to measure progress along the way for these projects.

We have found, for example, in the Office of Science that they have made great progress in this area and overcome some of these issues associated with the major projects.

Chair GORDON. So you are trying to make me feel better when we do this again?

Mr. GAFFIGAN. Well, I mean, look. These things are high risk. I mean, even FutureGen is a high-risk issue, and that is why the government is sort of stepping in to try to help in partnership with the private sector to share that risk.

Chair GORDON. Well, that is the next point I want to get to. Is this type of project being done anywhere else now?

Mr. GAFFIGAN. Not that I am aware of.

Chair GORDON. And as we see climate change legislation looming over us, would this not be an important tool in our box to move forward if we are going to continue, which I think we have to, with coal-fired plants?

Mr. GAFFIGAN. I think absolutely. I think it is one of the issues addressing the technology barriers. I would also point out that there are other issues that need to be considered in concert with that, including the regulatory and legal framework with carbon capture and storage as well as what are we going to do about carbon? Are we going to be able to send a signal to the market? Because ultimately, we could put all the money we want into these projects, and we testified last year that the government has spent over $60 billion, or close to $60 billion over the last 30 years in advanced energy technologies, yet we are still heavily reliant on conventional fossil fuels. And it can't just be the government spending money, it has got to consider the context of the private market.

INTERNATIONAL COOPERATION

Chair GORDON. Ms. Forbes, if I could pontificate a little bit on a pet project of mine. These are going to be very expensive programs, carbon capture and sequestration, and these are times of limited resources. It seems to me that we should follow up on a proposal that was made at the G–8, I guess it was last year, to do an international type of cooperation with this. Particularly in this area and energy in general, I sort of see it as "them that have it and them that don't," and we are in the don't category and that particularly with coal, where we have so much coal in contrast to oil and gas, that we should look at some type of international cooperation in terms of sharing both the intellectual part of it as well as the financial part, maybe take different geological formations that one country might have, we would take a couple here, someplace else there. Is that reasonable and could you elaborate on that some for me, pros and cons?

Ms. FORBES. Yes. I think that we have some existing frameworks for international collaboration on this subject. One of the things that is happening right now is that at the request of the G8, the International Energy Agency is developing an international roadmap for CCS. I think that document is set to be released in October. It will be significant, and it will outline the global suite of demonstrations that are in various stages of planning, but yes, I agree with you. We need to work globally.

Chair GORDON. Yes. Will it help lead to any kind of a contract or treaty where there will be coordination and cooperation in this effort, or is it just give a new menu of what is going on now?

Ms. FORBES. The roadmap will be a document. It will outline how to get to the 20 demonstrations by 2020. I think that beyond the roadmap, we need to revisit some of the existing bilateral agreements with individual countries and form new partnerships where warranted to collaborate specifically on demonstration.

Chair GORDON. And is G8 the best vehicle for that or is there any other vehicle that you would recommend?

Ms. FORBES. I am not sure, but I would be happy to get back to you on that.

Chair GORDON. It seems to me that at the end of the day, and again this will be expensive, it is going to have to be head of state to head of state making the agreement and the commitment because it will have budgetary impacts. Then you are going to have to have again some vehicle to coordinate that. So I would appreciate if you would give me any of your thoughts.

Ms. FORBES. Thank you. We will do that analysis.

Chair GORDON. And thank you, Mr. Chairman.

Mr. COSTELLO. Thank you, Chairman Gordon. Just for the record, let me state that Ms. Forbes has indicated that the original concept and project that was proposed had a lot of international interest from China, India, Australia, and a number of other countries who pledged money and were willing to cooperate and work with us. When it comes back to my turn for a second round of questioning, I want to talk a little bit about that and how the fact that the previous Administration, when they pulled the plug on this, how our international partners were notified and if in fact we can bring them back to the table and have them work with the Alliance.

The Chairman now recognizes the Ranking Member of the Subcommittee, Mr. Inglis.

PROJECT SCALE

Mr. INGLIS. Thank you, Mr. Chairman. Mr. Monroe, I think you had the key word here that I have heard, and that is scalability. So I am wondering, the projects that Southern Company is doing which are very exciting, what percentage of the CO_2 emissions are involved there? Do you have any idea? They are big numbers in terms of sequestration there, but in terms of the percentage of the outflow, what would it be? Do you have any idea?

Mr. MONROE. They are fairly modest. With the exception of the new integrated gasification combined cycle plant I mentioned in Mississippi which would be 50 percent of 600 megawatts, so that is significant. The other projects are really taking a stair step approach. In the utility business and with our cooperation with the Department of Energy, we found that if we try to take too big of a step, we make too many mistakes. We tried to sort of step in a factor of 10 almost, so we are talking sequestration or size. So the two projects I mentioned, the first one a 25-megawatt, the second one, 170 megawatts are fairly small by power plant standards. So our largest power plant is 3,600 megawatts. So that roughly is only about five percent at the largest scale we are talking there. Some of the actual plants that we would be looking at would be anywhere from 30 percent to say 10 percent of the total plant output at the largest scale that I mentioned on the existing plants.

Mr. INGLIS. I am also excited for parochial reasons to hear that you are interested in the IGCC because General Electric is in Greenville, South Carolina, and that may help business there and other places. I am very excited about that, and it is very exciting technology. And so now I am going to ask a question against my own interest. Why would Southern Company be interested in doing that? It is more expensive than sort of a conventional coal-fired plant, right? Are you just good citizens?

Mr. MONROE. We really see the future as being one that we expect limitations on carbon emissions, particularly for our sector. So to try to sort of smooth that transition, to try to service our customers as reliably as possible, we are spending more money for that generation than it would be for the alternative.

PUBLIC SERVICE COMMISSION CHALLENGES

Mr. INGLIS. Do you have any trouble with the PSC, Public Service Commission, getting that approval? I hope not, but something tells me you might, and this is one of the issues that Duke is encountering in South Carolina. You know, you deal with nuclear, it is a great way to make electricity, but getting it through the PSC can be really difficult because it sure is cheap to make coal-fired electricity.

Mr. MONROE. Yes. On the project in Mississippi, we have asked. In mid-January we had submitted the request for their consideration for their approval of that. We do have a little bit of help there in the fact that our CO_2 will actually be—we can sell that to oil producers in Mississippi so that we are not paying to do a geological sequestration test but actually selling it. It will eventually be sequestered in those enhanced oil recovery operation, but that is a benefit there.

Mr. INGLIS. It makes economics work a little bit better for you there.

Mr. MONROE. But still not compelling, so that the Public Service Commission is still one that is very much up in the air for that plant.

Mr. INGLIS. Got you. Interesting. Of course, those economics would change, I take it, if there was a price attached to carbon, either through what I would like to see as a revenue neutral carbon tax or cap-and-trade. Either one would cause those economics to change, I suppose, and the Public Service Commission would be more easily convinced I suppose?

Mr. MONROE. Yes, we do see that changing. Our fear and the reason we are pushing so strongly now for technology is that we are afraid of a dash-to-gas so to speak. So if you run the numbers right now, we need more electricity generation, natural gas is the one that falls out when you put all the numbers down on the paper. So we think that we have to do this sort of work both sort of at scale and go back to universities, national labs, in cooperation with utility companies, to see if we can find new technologies to make that cost differential so that coal becomes one choice that is still valid in the future.

Mr. INGLIS. And I am very excited to hear about Southern Company's commitment to this kind of research. I had an unfortunate meeting one time with a utility that will go nameless that told me that they didn't have an R&D department, and they seemed sort of proud of it that they didn't have one. And I guess it is because they didn't want to say to the PSC that we got all this in our cost structure, but hats off to you all for wanting to pursue the answer and somehow getting the PSCs in various places to agree that it is okay to pay all those people.

Mr. MONROE. It is part of our personality, and we take a lot of pride in the fact that we have a very active, very aggressive—some of the international cooperation that was mentioned earlier, on some of these projects we have talked to people in Sweden, in Denmark, in Germany, Japan, and England about participating in our project and sharing information there. So the benefit of having a research staff and active organization is you can reach out and find these technologies.

Mr. INGLIS. Great. Thank you.

Mr. COSTELLO. The Chairman thanks the gentleman and now recognizes the gentleman from New Mexico, Mr. Luján.

PROMOTING SUSTAINABILITY

Mr. LUJÁN. Mr. Chairman, thank you very much, and thank you for putting this hearing together. Doctor, you opened up your remarks and you made a reference to being responsible and sustainable. Can you refresh my memory on what you said in that context?

Dr. DER. I think the context was in the use of coal being environmentally sustainable and responsible in terms of its use, and that relates to the emissions and the carbon aspects of it.

Mr. LUJÁN. And Dr. Der, would you agree that as we are talking about the future generation of energy in the United States as well as around the world, that that is really a concept that we should adopt and embrace as we are moving forward with the generation?

Dr. DER. I believe so.

Mr. LUJÁN. Is there anyone on the panel that doesn't agree that that is where we need to move energy generation when we are talking about being responsible and sustainable with the way we are going to be generating power today and tomorrow? That is great to hear.

As we are discussing the future of generation and some of the improvements that are being invested in and made by utilities across the country and some of the awareness that is being generated around the world, Mr. Monroe, what is one of the biggest reasons that your company has moved forward with commitment in research and development? Is it to be more responsible the way that we are generating power today, to do things better than the way we have been doing them in the past, maybe?

Mr. MONROE. It is sort of a balanced view, is to—we have always tried to balance sort of the cost of electricity we supply to our customers with the environmental footprint that our generating plants have. And so as we become more aware of how our emissions may effect the climate, we have become much more worried about that and so have moved forward with research trying to anticipate.

What we don't like is to suddenly have very steep changes in the way we would generate electricity, and so we view through research a way to sort of smooth out that path so that when we see a future transition coming, we start actively working on it.

Mr. LUJÁN. So with that being said, would you agree that we can do things better than the way that we are doing them today when it comes to the way that we are generating power from the various resources that we have, renewables included?

Mr. MONROE. Yes, we can, but again, in this concept of balance between affordability of electricity and what we do, environmental footprint, that is our main concern, is sort of doing a good job for our customers to bring them affordable electricity. In your area of the country, renewables are much more accessible than they are in the southeast, so we have been working quite hard to try to find out how to do significant renewables. We don't have much wind in the southeast. The solar energy appears to be there, but because of haze and humidity, it is not that effective in the deep south. So the one area that we look at the closest is biomass. And so we are in the process as we speak of converting one of our older coal plants, taking the fuel away as coal and adding it as wood from the forests of Georgia. This is in Albany, Georgia, a small plant, about 100-megawatts. So we are moving in that renewable direction as well. We are also investigating nuclear power as a way to minimize that environmental footprint.

But as I mentioned in my testimony, we are still a very large, coal-based sort of system, so we have started to put lots of resources into looking at, is there a way to lessen the footprint of these coal plants?

ON THE AFFORDABILITY OF CLEAN COAL

Mr. LUJÁN. Thank you. Dr. Der, when we are talking about the future of generation of electricity, the way that it is moving forward, when you talk about pulverized coal and the way that it has been generated in the past and the concern about moving forward and the support, even though the project didn't move forward under the previous Administration with this whole concept of clean coal, I noticed that in your testimony that you talk about advanced coal but the only mention of clean coal is in the description of some of the agencies that are working with you. Is there a reason that you chose to use the word advanced as opposed to clean?

Dr. DER. Yes. I think advanced coal implies that we are working on technologies that make it clean which would include the capture, the carbon associated with it. In advanced coal, we are trying to move that yardstick forward to looking at technologies that are affordable that allow us to reach those goals of reducing those emissions including carbon.

Mr. LUJÁN. And one last question, Mr. Chairman, Dr. Der, as we are moving forward with the way that we are looking at generation today, should future proposed coal-generating facilities be really maybe put on hold or considered to scale back until we are able to move forward and develop these important technologies there have been such a serious investment in?

Dr. DER. I think because of the projections and the increase in the electricity demand and the needs for this country and around the world, I think we still have to retain that option to move forward while we work on the research to reduce that cost and its performance. We need to move forward in a parallel approach for the same reasons that Mr. Monroe advocated, that we need experience in looking at some of these coal plants that we can put carbon capture and storage onto, even though they are expensive now, and the experience that we have from doing that are lessons learned that allow us to do things a little more efficiently while we bring down those costs and wait for these new technologies to be put on and replace these technologies here. So I think the overall future demand would probably not allow us to maybe put a hold on coal. We should do it as we say in an advanced, clean manner, including the carbon capture.

Mr. LUJÁN. Thank you, Mr. Chairman.

Mr. COSTELLO. The Chairman thanks the gentleman and now recognizes the gentleman from Florida, Mr. Diaz-Balart. Thank you. The Chairman now recognizes the gentlelady, Ms. Edwards.

CONCERNS AND SKEPTICISM ABOUT CCS

Ms. EDWARDS. Thank you, Mr. Chairman, and thank you to the panel. I am just curious. I just want to be really clear about that. Can you just raise your hand if you are at all skeptical about CCS as a future technology? Can you please describe your skepticism, and especially as it relates to reaching peak greenhouse gas emissions in 2015?

Ms. FORBES. We have to demonstrate it. I think the reach is really promising, but we haven't done it at scale and I think one of the things that we learned in developing the guidelines, we have to balance our confidence about the fact that we think this technology is going to work and it is an important part of a portfolio solutions for climate change with the fact that there are still questions that we don't know, questions that can't be answered until we move forward with the demonstrations.

Ms. EDWARDS. Can I just ask, just in terms of the amount of the expenditure over the lifetime of this particular investigatory stage that could be spent not just in renewables but in existing coal plants and making those more efficient because they exist? It seems to me a lot of the discussion is about building new plants, and in this country and around the globe, we have old plants that are in existence that are inefficient, that are producing CO_2 emissions at tremendous scale and yet we are investing in a technology that may or may not work in 20 or 30 years.

Ms. FORBES. Technology for carbon capture and storage must include approaches that apply to the existing fleet to post-combustion capture. The original FutureGen was an integrated gasification combined cycle would be a new plant, but CCS broadly should explore opportunities to deal with the existing fleet as well as the plants that they are building in China and India right now.

Ms. EDWARDS. And is it your view that the current plan, the evolved plan from the canceled FutureGen project, focuses on existing plants?

Ms. FORBES. I would defer that question to Mr. Gaffigan. I believe it allows for existing plants for post-combustion, and I think that is one of the pros of the new approach, but I also think there was a substantial investment in the original FutureGen that shouldn't be ignored. I think there are advantages to both approaches.

Ms. EDWARDS. Mr. Gaffigan.

Mr. GAFFIGAN. It allowed for both.

Ms. EDWARDS. Is that what is happening?

Mr. GAFFIGAN. We don't know. DOE has gotten a small number of proposals from the restructured FutureGen. They have asked for more information from some of the proposals—right now it is in the negotiation phase. I don't know if Dr. Der has an update, but right now the main difference to think about is, you know, the original FutureGen was an exclusive focus on IGCC, and whether that is good or bad, I will allow the policy-makers to decide. It was an exclusive focus. It was considered one of the tools going forward. And the difference now, even in the initial proposal for restructured FutureGen, it talked about an IGCC focus, but when the actual bid went out for proposals, they had also allowed for others to include existing.

Ms. EDWARDS. And how many existing coal plants do we have in the country? Anybody know?

Mr. GAFFIGAN. Somewhere over 600 in this country I guess, according to Dr. Der. It depends on the size of some of these plants. Some are very small. We have heard figures of about 1,100 but that might include some really small plants.

Ms. EDWARDS. Okay. And then Mr. Gaffigan again, in terms of the cost, I mean, I understand you know, the math error which is unbelievable. I mean, we should send everybody to second grade. But I wonder, even in the best circumstances, would a 39 percent overrun have been acceptable over the life of a project?

Mr. GAFFIGAN. Potentially again, as these are very preliminary cost estimates, and you are going to see some cost escalations, especially with state-of-the-art and new R&D type things. Whether 39 percent is tolerable or not, that depends on how it is managed throughout. What I would point out again is that there was a new cost estimate being prepared that probably would have given better information and was more site specific.

Ms. EDWARDS. But I mean, in fact though, if GAO were evaluating a project, whether it is in this department or another department with a 39 percent cost overrun, you would have raised some questions about that, wouldn't you have?

Mr. GAFFIGAN. Well, we have, sure, depending on how it was handled. I mean, they could have decided that they wanted to pursue a different scope, and it was agreed upon that that would cause the cost increase. It is whether it is managed or not that I think is key. I mean, there are some projects in DOE we just recently tested more on the weapons side. I think we looked at eight out of ten projects, and combined, there was over $14 billion in cost overruns.

Ms. EDWARDS. Yes, I know, and I think a lot of us have some concerns about that. And then just out of curiosity, Dr. Der, I wonder if you could talk to me about the ability to rely on a projected operation or commercialization say in 20 years with investments, even in the revamped FutureGen and how that relates to what we might take that same money and spend on other kinds of technology that would serve to reduce carbon emissions in the 20 to 30 years?

Dr. DER. I think given the magnitude and the reliance that not only the United States has on coal for power generation but the rest of the world, I think it is important for us to work on solving that problem. You are right in saying that we have an existing fleet and Mr. Gaffigan was talking about the fact that the FutureGen project looked at new construction. Our program is more comprehensive than just looking at the gasification. It addresses the capture, the stack capture of carbon emissions from existing fleet. It is a challenging and daunting task. The Secretary is committed to focusing on that as an additional area of emphasis as well. So I think the problems should be worked on now.

Ms. EDWARDS. Thank you, Mr. Chairman.

Mr. COSTELLO. The Chairman thanks the gentlelady and now recognizes the gentlelady from Texas, Ms. Johnson.

ORIGINAL FUTUREGEN PROJECT CANCELLATIONS

Ms. JOHNSON. Thank you very much. I know that this was a different Administration, but why was the project canceled last year or in the last two years?

Mr. GAFFIGAN. We were asked that question, and we asked over and over again, and we were told that it was because of the cost doubling. And we were pointed to the Secretary. It was his decision, and we were pointed to his testimony on the matter. So the bottom line for the most part the answer was because the cost had doubled.

Ms. JOHNSON. And you are ready now to look at it again for less cost?

Mr. GAFFIGAN. Well, I guess that would be up to the current Administration, whether they want to look at it. Our point was that there were very preliminary cost estimates, and to throw out this doubling was really not accurate in terms of the potential cost increase. I don't know if Dr. Der wants to add to that.

Dr. DER. It is my understanding that the Secretary is planning to meet with the FutureGen Alliance to restart discussions on this particular project.

Mr. COSTELLO. If the gentlelady will yield to the Chairman?

Ms. JOHNSON. Yes.

Mr. COSTELLO. The reason as you will recall given by the Administration for canceling the project was the escalating cost, and the Administration indicated they didn't anticipate the increase in costs. They were using, as Mr. Gaffigan—I won't put words in your mouth. If you will explain the numbers that they were using in terms of real dollars versus——

Ms. JOHNSON. Imaginary.

Mr. GAFFIGAN. Well, roughly, and this is ballpark, they were talking originally about a billion dollar project. They compared that to an escalated cost through 2017 of $1.8 billion. If you took those dollars and took them back to the same year's dollars, you would be talking about roughly $1.3 billion. So the actual increase that the Alliance brought forward was about $300 million. And I also point out that that was discussed in March of '07 when they signed the latest cooperative agreement or the next part of it, the continuation. It was only after that then that we started questioning this cost and then the concerns about the doubling of costs started to be talked about.

Mr. COSTELLO. And I would point out to the gentlelady that Chairman Gordon, Chairman Baird and myself and Mr. Lipinski asked the GAO to do a report and to look at the reason. You know, was it in fact cost, and I think the GAO report which is being released today will indicate that it was not cost and was not justified stopping the project because of cost. And they looked and analyzed the numbers and said that the Administration was not using accurate figures.

I pointed out earlier, too, in an earlier Subcommittee hearing as you will recall, if you look at other projects in the same timeframe that increased in cost, it was as a result of the increase in cost of building materials, concrete, other materials, as well as labor. So I thank the gentlelady for yielding.

Ms. JOHNSON. Thank you very much. That is the end of my question.

Mr. COSTELLO. The Chairman now recognizes Mr. Tonko.

INFRASTRUCTURE AND RESOURCE DEMANDS

Mr. TONKO. Thank you, Chairman. Thank you for this important hearing, and I thank the panel also. Dr. Der, the issue of infrastructure for carbon capture and storage is one that comes up often, and I am wondering where the Department might be in terms of analyses that are done or any efforts being done on a process to address pipelines that might be required to deal with the point of emission onto the storage area and if there is a plan to do that in a national framework.

Dr. DER. The pipeline infrastructure that would be associated with carbon cap and storage, depending on how far the transport of the CO_2 goes, could be considerable. The jurisdiction as I understand it relative to pipeline infrastructure and regulations does not rest with the Department of Energy; it rests, I believe, with the Federal Energy Regulatory Commission and to a large degree with the states.

Mr. TONKO. Is anyone else on the panel able to offer any thoughts on that as to how that infrastructure may be addressed in your particular cases?

Mr. GAFFIGAN. I would just offer one thought, and I think it goes to Ms. Edwards' earlier comment about, you know, are you skeptical about CCS? I don't know if I am skeptical. What I would say is there are a great deal of uncertainties, and this is definitely one of them, the infrastructure to move the CO_2 around at the scale that Ms. Forbes is referring to. I mean, I think we know we can do carbon capture and storage. Can we do it at this huge scale and put all this stuff, move it around, put it in the ground and hope that it stays there?

Mr. TONKO. And in terms of another bit of infrastructure, with water demands that may be increased and enhanced, are there efforts being made to review just what the water issue might be for some of these facilities?

Dr. DER. Yes, I think there was a panel yesterday that talked about water and energy nexus and the discussion that centered around carbon capture and storage did indicate that there would be an increase in water usage given the current capture technology that exists today, and one of the things that the Department of Energy is looking at are advanced capture systems that would reduce the consumption of the water as well as the energy penalties associated with it as well as the cost of the components.

Mr. TONKO. Thank you very much. Now, as in my last station before coming here, I was at NYCERTA in New York with the Energy, Research and Development Authority. I know there are those who are looking for sequestration facilities, and there are a lot of concerns about the price obviously and a number of the dynamics that need to be addressed in order to provide for a safe and effective outcome. But I thank you all for your input.

Mr. COSTELLO. The Chairman thanks the gentleman and now recognizes the Ranking Member for another round of questioning.

Mr. INGLIS. Thank you, Mr. Chairman. You mentioned breakthroughs earlier and the hope for breakthroughs. Help me figure out where is it likely to come from. Anybody want to take a shot at what kind of technologies, what kind of processes might give us these breakthroughs?

Mr. MONROE. I will start. The technologies we would use today, and it really doesn't matter whether it is IGCC or a conventional coal plant really, are adapted from chemical and petroleum industries. They use a water-based chemical, a basic chemical to capture the acidic CO_2. Part of the energy penalty is, and you mentioned the water usage, that is part of the water usage. So we capture the CO_2 with this water mixture, we have to take it somewhere else to get the CO_2 to turn loose, we reuse the chemical and it is really the heat to make that CO_2 turn loose that makes it so expensive on the capture side. It is the energy to do that. That is the biggest piece we looked at for benefits there. We still have to compress the CO_2, so there is still a significant sort of energy to make it a high enough pressure to put down a pipeline or even push underground. So we are really looking at how to take CO_2 out of the stream.

So I will mention some that are interesting to us. Some are solid chemicals that could capture the CO_2. Then we wouldn't have to heat up this 70 percent water and waste all of that heat. Membranes to sort of on a molecular level filter the CO_2 and get the CO_2 to come through this filter, but the rest of the gas not come through, are some of the most promising ones right now.

Mr. INGLIS. Anybody else want to——

INNOVATIVE TECHNOLOGIES

Mr. GAFFIGAN. I just want to weigh one thing in terms of the technology. Obviously, GAO doesn't bring the technology to the table. We were really impressed with the wide range of expertise that is out there, both in the private sector and at DOE. But what I would say is going to sort of bring the breakthroughs is the incentive to do so and to let that private sector get out there and do those things. And I think one of the signals could be some regulatory certainty about what we are going to do about carbon. That would bring that private sector to achieve some of these breakthroughs.

Mr. INGLIS. Interesting.

Dr. DER. The Department of Energy and its national laboratories and universities are actually working very hard on this particular issue about the energy penalty and the costs associated with these revolutionary ideas, and as the Secretary mentioned, these transformational, game-changing technologies. Some of the ideas out there right now include the clafate capture of the CO_2, which basically is, it locks it into a structure and you can re-release it. There are ideas know as ionic liquids where it is basically a filter where the CO_2 goes into these spaces and again, with just a very small amount of energy and pressure differentials, you can re-release that as well. So the key here is capital costs, energy penalty reduction, and making sure those technologies integrate well with the power plant or any other type of industrial source.

Dr. FINLEY. I would like to add one more comment. I think it is very important if we look at some of the soft ideas, though not hard technologies, we need to relate to. We need to understand who owns the pour space. We need to understand a regulatory framework in which this will take place. We need to understand, how do we go about leasing the subsurface rights in the land areas for large-scale demonstrations? And not only that, we need to look beyond—we are now at the deployment phase for testing. What happens for example in a given geological region if, for example, you have 20 of these projects putting away five million tons a year per project in the subsurface? What does that do on a large regional scale to aquifers, the subsurface environment, and so forth because ultimately the scale of this to be totally effective could become quite large, and the issue of public acceptance and the framework in which this takes place legally and from a regulatory framework must also be looked at.

Mr. INGLIS. Any idea whether China has favorable geological formations for sequestration? Anybody know that?

Ms. FORBES. There have been some preliminary studies. It looks like there are some willing gas fields in China that are promising that would be potential opportunities and also some of the U.S. geologists have been going over to China and working with the Chinese, specifically with Shenhua to look and see—that is the biggest coal company in China—to see, associated with one of their big coal-to-liquid plants. They are doing a test injection, and they have been doing real characterization of the geology to determine how it is going to work. It is potentially promising.

Mr. INGLIS. Very helpful. Mr. Gaffigan I think has a key thing there that is so exciting to hear, the concept of the private sector having an incentive to do this because you know, what Microsoft and Apple did for the PC and the Internet, the private sector properly incentivized by a price signal being attached to this negative externality and have that attached to the product would drive innovation faster than anything we could do from this Science Committee or anything we could do in Congress.

Mr. GAFFIGAN. Absolutely. It goes to your point about your PSC's. They are not going to approve things until they see it is in their best interest. Most of the folks out there are in a wait-and-see.

Mr. INGLIS. Right.

Mr. GAFFIGAN. They are wait and see.

Mr. INGLIS. Thank you. Thank you, Mr. Chairman.

PROJECT SITING

Mr. COSTELLO. The Chairman thanks you. Dr. Finley, in your testimony you talk about the importance of characterization, and I wonder if you would talk about how long it takes to conduct robust site characterization and also the cost associated as well?

Dr. FINLEY. I think if you were to start at ground zero, let us say in a region where you know such a project currently existed, you would probably need at least a year to put together a full-scale geologic framework based on existing data. At that point in time, I think you would be ready to run geophysics and to perhaps drill a preliminary well, a stratigraphic test. Carrying that out and aligning that data would take you at least another year or so I would think, a two-year process at a minimum from the get-go to at least to have an understanding of whether a site would be suitable. I think the cost of doing that at a minimal framework could be in the range of let us say $15 to $20 million.

Mr. COSTELLO. And do you know how much the State of Illinois spent on looking at the sites in the State of Illinois in order to make their case to the alliance?

Dr. FINLEY. I believe State funds, certainly several million. I don't know the exact number, but I know that almost $1 million was spent in the State of Illinois funds since the project was canceled alone to demonstrate the continued suitability of the site and the contribution that the State made to the Alliance purchase of the 400-plus acres for the site.

Mr. COSTELLO. And I think that is one of the points that I made earlier about being outraged in pulling the plug. This was a competitive process, and the State of Illinois and other states as well spent millions of dollars in the competition. So I wanted to point that out. If you start from ground zero, you are talking about a minimum of a two-year process and at least in Illinois, my knowledge of the site that the Alliance selected, the State of Illinois spent well over $10 million and probably closer to $20 million in this competition.

Dr. Der, let me ask you, and I don't know if you are in a position to tell us, but to your knowledge, how is the Department planning on spending the funds available under the Recovery and Reinvestment Act?

Dr. DER. The guidelines that were put into the legislation put monies into certain pots of that $3.4 billion. There is $800 million that is going to go to augmenting the CCPI round three which includes carbon capture. There was another $1.52 billion in there for looking at industrial carbon capture and storage projects, $50 million associated with the characterizing additional sites, $20 million for some research and training on the geological sequestration. The remaining $1 billion is something that the Secretary and the Department is still making decisions on and will probably come to that shortly.

Mr. COSTELLO. Would you in your opinion being involved in the FutureGen program in the Department for the last five-plus years, would you classify the FutureGen project as a shovel-ready or near shovel-ready project as far as sequestration is concerned?

Dr. DER. I would probably characterize it as something that would be near shovel-ready. We have to probably finish up some work that was not finished up in the preliminary design phase that was specific to that particular site, do some more of the characterization that Dr. Finley talked about specific to that and finish up the design. And after doing something like that, it would be pretty much ready to go forward.

Mr. COSTELLO. Is there any sequestration project that you are aware of that is more advanced or ready more so than FutureGen?

Dr. DER. Not to my knowledge at the current time, sir.

Mr. COSTELLO. Last question, Dr. Der, can you share with us some of your thoughts or concerns about the restructured FutureGen program?

Dr. DER. I think when you look at it on balance, the restructured FutureGen program sort of addresses a different issue than the original FutureGen. The original FutureGen as an advanced platform for testing these new technologies was to push the stick forward, if you will, on the technology for gasification. In the restructured FutureGen, it focuses on putting technologies that we have today onto existing commercial platforms and to gain that kind of experience early on, and that in itself also has value. So it is a judgment call as to, you know, which way do we go on something like that.

INTERNATIONAL PARTNERSHIPS

Mr. COSTELLO. My final question of you, Dr. Der, and I would ask Ms. Forbes or any of the other witnesses to comment, we talked about international partners that were very interested and committed actually to participating in the FutureGen project, China, India, a number of other countries. One, my understanding is the way that some of these countries found out that we were pulling the plug is they read it in media reports. They were not given advanced notice. Two, do you feel that the interest will still be there that we can still bring these other countries and international interest into this project?

Dr. DER. I think the Secretary Chu has indicated that it makes sense for countries to collaborate and coordinate its portfolio projects, and I know that he has been taking a very proactive position in contacting his counterparts around the world. And I have all the confidence in the world that he will be successful in doing that.

Mr. COSTELLO. Ms. Forbes, would you want to comment?

Ms. FORBES. Yeah. Based on our experience in working with some of China's leading CCS experts, I would say there is definitely interest in collaboration on demonstrations and also on issues that are associated with policy and regulatory and really building capacity. They like to work together.

Mr. COSTELLO. Any other comments from——

Mr. GAFFIGAN. Just a quick note, you know, I think the international partners were putting out money toward this, up to eight percent, and one of the considerations in looking at options for cost escalation was to look for whether they were going to contribute more. And as I understand it, we still have the money from India, so we need to make a decision there one way or the other.

Mr. COSTELLO. Dr. Finley.

Dr. FINLEY. I think your point is very well taken. It is all one atmosphere, and I think to the extent that we provide technology in a collaborative manner with international partners around the world, I think it is absolutely essential. I think in some cases these partners for example are not even totally aware of the level of effort that the United States is making, and I think in part the case when the Chinese delegation visited our site in Decatur, they were very excited to see an actual well going down into which we would put a million tons of CO_2.

Mr. COSTELLO. The Chairman thanks you and now recognizes the gentleman from Florida, Mr. Diaz-Balart.

Mr. DIAZ-BALART. Thank you, Mr. Chairman. I will be brief. GAO had said that incentives would really come from regulatory certainty and that a price on carbon would spur technological innovation in effect. Are we seeing those technological innovations coming from Europe as far as CCS is concerned? How much and how dramatic and how aggressive?

Mr. GAFFIGAN. The international expertise is not my bailiwick, but I will say from what we have seen, you know, they are struggling with their system to figure out, is it working? And I think we will probably go through some of the same things.

My point in general is that in this country, folks are looking for that regular certainty. Some folks like Mr. Monroe's company are trying to hedge a little bit and anticipate what might happen. I am not as familiar with the international activities in Europe. I don't know if Ms. Forbes might be.

Ms. FORBES. Three things that I would like to mention going on in Europe. First, the European Union has finalized a directive for geologic sequestration which includes the environmental regulatory structure for how to do CCS responsibly. There has also been an effort, and this is in my written testimony as well, to commit funding for CCS demonstrations, a network of 10 to 12 throughout Europe through proceeds from the European trading scheme. Additionally, some of the European utilities have been really proactive. It is my understanding that one of the European utilities actually has pilot-scale tests of each of the commercial capture options that are out there today, and they are currently operating and basically testing all of them to see which one operates the best.

Mr. DIAZ-BALART. Again, we are not—I am sorry. Yes, sir?

Mr. MONROE. We see lots of ideas coming to the table now, so people are engaged in the subject. We see the beginning of sort of basic R&D sort of really kicking off now. We do worry about too much regulation too quick and that sort of we would be forced into building gas generation, then, to meet that. So we see the sort of ingenuity of the American people in the university system and national labs already engaged on this issue. They are not waiting for anything further.

Mr. DIAZ-BALART. I am not saying that you should know obviously, but do any of you have any real idea as to what we have seen with these technological breakthroughs coming from Europe? Because they do seem to have some I guess certainty. Has Europe become the bastion of CCS technological innovation?

Ms. FORBES. I think U.S. R&D program for CCS is among the best in the world. The Europeans are also doing a lot of work. They have gone further on the policy and regulatory side than we have here in the States. But our research program is—the IEA did a study, and it called the Regional Partnership Program specifically the world's most ambitious program. Unfortunately, that program is not very well known internationally, and I think we could do some programs to offer exchanges to get more experts like Dr. Finley in the international community and get some exchange happening.

Mr. DIAZ-BALART. Thank you. Thank you, Mr. Chairman.

THE VIABILITY OF CCS AS AN INVESTMENT

Chair BAIRD. Thank you. I'm sorry I had to step away. We had action on the Floor and a bill I had worked on, ironically on ocean acidification, so maybe appropriately so. As I look at this capture and sequestration, I have a couple of questions that come to mind. I will put those out there, and maybe you can address them. One has to do with just estimated net capacity. In other words, what is the width of likely amount of carbon that we can capture, and timeframe. The best climate change/acidification scientists I know of say that we should shoot for nothing higher than 350 parts per million as a goal, and we already exceed that in terms of atmospheric loading of CO_2. We already exceed that, and so my question is, how long is it going to take us to get some meaningful reduction in CO_2 output, and what is the likely capacity we can. And my hunch is it is going to take a long time and we are not going to be able to ultimately get that much out. And then the question for me is should we not then focus on other modalities as a priority for our financial investment? I will just put that out there, and whoever wants to take a swing at it I am happy to hear from.

Dr. DER. You are all looking at me. From what I have read in the literature, including the IEA reports, if we are going to come down to some kind of a stabilization in the atmospheric concentrations or whatever level that is key, it shows that carbon capture and storage, along with the other mitigation measures, constitutes somewhere around 20 percent. Other reports say a little bit higher. That tells me that it needs to be an essential part of the portfolio of mitigation measures, along with efficiency, in-use efficiencies, nuclear, wind, solar, and natural gas. So it is very difficult to get to stabilization without looking at carbon capture and storage because of the existing inventory that we have out there that relies on fossil fuels.

The other thing is that the storage capacity at least in the United States. Dr. Finley could probably answer the question better than I. We have done a national atlas of the storage capacity in North America, primarily Canada and the United States, and it shows that we have considerable storage capacity, several hundred years' worth. And looking at the point sources where the power plants are and where the potential storage sites might be, and what are the reasons for looking at saline reservoirs is because that type of formation in the wet sands represents the majority of that storage capacity. And I defer to Dr. Finley to augment my statement on that.

Dr. FINLEY. Yeah, I can quote you the numbers from memory for the Illinois basin, just to give you a representative example. That region of Illinois, Indiana, and western Kentucky emits about 304 million metric tons of CO_2 per year from stationary sources. 90 percent of those sources are coal-fired power plants. So we have got say a third of a billion tons. The storage capacity in the saline reservoir as Dr. Der mentioned is roughly between 27 and 109 billion metric tons. So we have at least probably in the order of at least 100 years of storage, possibly 400 years of storage in saline reservoirs in this region.

The second version of the second edition of the atlas that DOE has put forth has refined some of those earlier estimated numbers. The reality is that certainly 200 years' worth of storage, if we could capture virtually all of the emissions from the known current stationary sources.

Chair BAIRD. What about the timeframe? When do we think we will be able to do this?

Ms. FORBES. I will be happy to take that question. I think that the question of the timeframe is really about what—we haven't demonstrated it yet. We don't know if can play. Right out analyses, as Dr. Der mentioned, of how we are going to get to global goals for climate change rely heavily on CCS. The IEA study says to cut 50 percent of the projected emission projections that we need to cut by 2050, CCS is for 20 percent. So unless we demonstrate the technology, it is not going to play. So ultimately, I think the urgency is on demonstrating it and how those demonstrations are going to go will depend on when we decide to do it.

Mr. MONROE. And I would agree with that. I work with the Coal Utilization Research Council, and they are probably the most active at looking at least for coal plants what is the ramp to get from where we are now to what we would call commercially ready carbon capture and sequestration. So it is different than commercial availability. Commercial availability is when someone will sell you something. Commercially available to us means when do the banks accept it for financing, the regulations are set. We can build a strong business case with Public Service Commissions' signing on for that for it to be ready. So in answer to your question specifically, we are looking at a timeframe of 2020 to 2025 if we are doing this demonstration sort of up-ramp between then and now so that we think at that point the utility industry would be ready to sort of start installing those as a normal matter of course. So when we look at that, between now and then, we are looking at maybe 15 gigawatts which might be as many as 30 plants sort of as part of this demonstration and development and sort of different options. So in this route, we like a lot of duplication. That is not great to hear, but we like different technologies. We think we need sequestration in different regions of the country for public acceptance regulatory sort of thing. So in this case, it sounds like a lot, but we do need those parallel paths to get there.

URGENCY AND THE CCS TIMEFRAME

Chair BAIRD. I appreciate that. I will close with just this concern, 2025 sounds like a long time away to me given the urgency of the situation. Already off our coast in the northwest we are seeing acidification rates that are presumably harming shellfish and other creatures, and 2025 is a long way away, and that is to start the installation of this and that is at substantial additional cost per ton of coal burned. So the question for me becomes economics, environmental impact, and practicality. It feels a little bit like having followed the debates on fusion energy for 20, 30 years now myself, it is always 20 or 30 years away. It feels a little bit like that, but the urgency is greater and maybe your technology is more promising. I would hope it is. But I just want to put that concern, and I would hope we would not see capture and sequestration as the deus ex machina that saves us. I think there may be other machinas if not other deuses. I am not sure. Dr. Ehlers?

Mr. EHLERS. Thank you, Mr. Chairman. As far as fusion is concerned, it used to be 20 to 30 years away. Now it is 30 to 40, so we are making progress. Just call me the Bernie Madoff of physics.

GLOBAL PARTICIPATION

I am sorry I missed most of the hearing. I had four committee meetings going on simultaneously this morning, but just a quick question. In the brief time I have been here, I heard a lot of different nations mentioned, but I haven't heard Russia mentioned, which I believe has tremendous coal reserves, and are they an active player here? The second is along the lines of the Chairman's question about when this is going to happen. I worry less about the science. We can do the science if we are willing to put the money in. I worry much more about getting acceptance throughout the international community, that this is something that is fiscally and environmentally worth doing. And is there any indication that all the other nations are willing to join in doing this if we do? Because otherwise, we are, given the use of coal throughout the world, even if we do a marvelous job in this country, it doesn't really solve the problem. So I would appreciate comments on those two questions.

Ms. FORBES. With respect to Russia, in the international CCS meetings that I have attended, I haven't seen Russia participating. I don't know that they have a demonstration planned, but there are a number of other countries worldwide who have plans for demonstrations similar to the FutureGen project. Australia has a project, China has a project, Europe is planning 12, Canada has a project. So we do have quite a global commitment towards demonstrations of technology.

Mr. EHLERS. And do we have the commitment toward implementation? That is the real key.

Ms. FORBES. I don't think we have commitment toward implementation yet. I think we have commitment toward demonstrating the technology. I think we are moving toward a global sweep of demonstration projects. I think implementation is the next step, and in some ways we have to talk about implementation now because of urgency of the climate challenge. But in other ways you can't talk about it until you have at least one demonstration in the ground.

Mr. EHLERS. I agree, but that is the part that I am very nervous about and that was, as far as I was concerned, the failure of Kyoto from the start. I thought the general idea of Kyoto was good, but I had trouble supporting it because it was made universal and it doesn't make sense that we spend billions of dollars in this country and many other countries to try to stop something when other countries are not going to do it. What we gain through our efforts, we lose through their efforts. So I think it is absolutely essential that there be strong international agreements if we are actually going to proceed with this. Thank you. I yield back.

Chair BAIRD. Ms. Edwards.

INVESTMENT THROUGH 2025

Ms. EDWARDS. Thank you, Mr. Chairman, and just an observation that again, 2015 peak emissions if we are right about our models, 2025, a demonstration project at some point of commercialization that may or may not be successful. And so we are actually relying at this time knowing that we are approaching peak CO_2 emissions on a technology that may or may not deliver in 2025. I mean, so we are banking on success here, and I want to ask you actually, I want you to think about failure because the cost for failure is really tremendous.

Dr. Der, I wonder if you could talk to me for a moment about, you know, if you think about the investment between now and 2025, what that investment would be? Does the Department have any projections for that and how much of a burden do taxpayers have to meet and what is the relative risk then for private entities and other international partners?

Dr. DER. That is a difficult question to answer at the moment. I think we have plans in terms of the projections of the research work and the demonstrations that are necessary. We engage with the private sector to get their views on what is necessary to move things forward in terms of demonstrations and incentives for deployment. It is very important that we do the science correctly in the sequestration area. I am not an expert in it, but I do have a higher degree of confidence that it will work based on the work that is going on around the world and the experts that are being put to this particular topic, people like Dr. Finley, people from the regional partnerships. The Secretary is also committed to working on the back-end capture costs and the energy penalties associated with that, as well as the science in terms of simulations and looking at the risk assessments associated with that. All these things need to be done as part of the research and development and demonstration program. Relative to how these things get deployed and what the private sector investment is going to be is something that I don't have an answer to at the moment.

Ms. EDWARDS. And just out of curiosity, are you confident about your model for projecting the cost?

Dr. DER. We have a research program that sets targets in terms of bringing down those costs from where they are now. We look at the research and the options that we have been pursuing, taking a look at what is its potential. And with those potentials we have to change that and convert that into reality as we scale things up. And those are one of the challenges that one of the Committee Members had also identified.

But we really have to be able to engage the science and technology to bring down the cost and also to do the modeling and the field work and all those things associated with field demonstrations, drawing on experiences that we have had in the past from the oil and gas industry and looking at the natural analogs of CO_2 that have been in the ground for millions and millions of years so that we can make these models and risk assessment in going forward in time.

Ms. EDWARDS. Okay. And then finally, just one question going back to Mr. Tonka's earlier question about water and the amount of water that you project that it will take to operate these plants, I am curious about electricity and the amount of heat that is required and electricity required to operate the plants and to function and their estimates. I think Mr. Monroe, in your testimony estimates that 20 to 25 percent of the electrical output is required for operation. There are some estimates I have seen that are as high as 40 percent. And so if that is true, it is just really getting difficult to see where the bargain is.

Mr. MONROE. Well, your earlier question talked about existing plants and why so much conversation about new plants, and your current question has something to do with that also. So if I go to an existing power plant today, let us say a medium-sized plant of 500 megawatts, I may lose a third of that generating capacity to add 90 percent CO_2 capture to that. So there is two large pieces of that. One is the heat required in the capture process. That is about 20 percent in round numbers. The question of the CO_2 is around 10 percent. Right now we would buy a large electric motor to compress the CO_2 to get rid of it. We would actually take steam away from the process for this heat.

We think in a new plant, again, talking conventional coal, that we may be able to integrate that and drop those numbers down. Right now we are looking at numbers possibly as only 20 percent. So the new plant would be built that way. IGCC is actually much less than that, and that is why it is a favorite technology for new plants. We are building a new plant with that. The FutureGen is proposed for that. Duke is building one that may or may not have CO_2 capture with it, and those are all sort of pioneer plants to try to develop that technology, just because we think the energy and therefore the costs for CO_2 capture with that technology, as we sit here looking today, is superior.

EFFECTS ON THE CONSUMER

Ms. EDWARDS. Of course, we have a lot of old plants, and just lastly, Mr. Chairman, do we have any idea what that will do to the consumer? Like how much is my electric bill going to go up because we have made the choice to make an investment in something that is sucking out a lot of energy to produce, you know, the carbon capture?

Mr. MONROE. There is a lot of people estimating that, so I will talk about a specific, let us build a new plant. How much would the cost of electricity from that plant increase with carbon capture and sequestration? Based on some of the good work that the Department of Energy has done, that ranges from a 35 percent increase to as much as an 80 percent increase, depending on the technology, the high end or conventional coal plants like we are using today, the lower end is with the gasification plants. So it is significant, and that is really the reason for demonstrations but also for the basic R&D is to really attack that.

Ms. EDWARDS. Thank you, Mr. Chairman.

Chair BAIRD. Thank you, Ms. Edwards. We are going to have a vote in just a couple of minutes. I want to follow up with this line of questions of Ms. Edwards and a bit on the line that I was asking before.

COMPARATIVE COST BENEFIT ANALYSIS

If we look at the net expense of carbon capture sequestration over some timeframe, and that would include the additional cost passed on to consumers, et cetera, the total net cost, and we considered how that money—you know, it is an opportunity cost kind of question. If we consider how that money might be spent elsewhere, for example, instead of a concentrated power network going out across the grid, a distributed power network kind of thing Amory Lovins and his folks have talked about, how does that pencil out? Has anybody thought about this? Pencil out not only in terms of net economic cost benefit but also in terms of timeframe and carbon reduction. If we were to spend X amount of dollars today, we could start reducing carbon today versus waiting this long and presumably that investment today would stimulate alternative investments in that technology be it solar, small-scale wind, geothermal, et cetera. How does that pencil out? I mean, the people at the end of the day, they don't care whether the lights turn on because somewhere down the road there is a coal plant, a nuclear plant, on the roof a solar plant, they want the lights to turn on and their house to be warm.

Mr. GAFFIGAN. I am holding a pencil, so I will try to answer that. I think you are going to hear on this committee over and over again, don't pick a winner, don't pick a winner as far as technologies. In our view, there is a winner. It is fossil fuels, and it ended up being picked for a reason because it is relatively cheap and gives the most power, whether you are talking about powering your automobile or through electricity. And I think there is so much uncertainty associated with alternatives or making a change. But the bottom line is, it is going to cost more to do so. And I think the Federal Government has to consider what its role is going to be in all that, and we have talked about the private marketplace. But some would argue that, you know, let us send some signals to the market saying there is a rule about carbon, it is constrained or it is priced, and let the market try to sort that out, so we can move from a pencil to maybe some more ink. And I do think there is so much uncertainty and there are so many tradeoffs with all these alternatives, whether you go with coal in the future or you look for wind or solar. Folks in Germany, for example, made a commitment to solar but they are paying more because of it. They have guaranteed a price for it, but that is a choice they have made. And you are right, I don't know if this will be acceptable to people. If the PSC today says, you know, we are going to approve a rate increase for carbon capture and storage, how is that going to go over with the rate-payers?

Chair BAIRD. I want to just follow up, Mr. Gaffigan. You said in our view. Does that mean GAO has an official position that—I want to ask two questions.

Mr. GAFFIGAN. Sure.

Chair BAIRD. I am not really trying to put you on the spot, I am just curious about this. When you talk about it relatively cheap, my colleague, Mr. Inglis, talked about the externalized cost.

Mr. GAFFIGAN. Right. Right.

Chair BAIRD. It is relatively cheap if you externalize the cost. If you factor in the total cost of ocean acidification and lethal overheating of the planet, it is not so relatively cheap.

Mr. GAFFIGAN. No, it is what we are actually charging for it, and that is the question whether we want to try to put a cost on some of those externalities. If we do so, then the rate-payers or somebody is going to have to pay for it.

Chair BAIRD. Right. Somebody has to pay for it one way or the other. You don't get to not pay for an acidified ocean. You don't get to not pay for a two or three degree Centigrade climate change. You don't get to not pay for that. That is going to happen. The question is who is paying for it and who is responsible for it, and that is not something we can pretend we don't pay for.

Mr. GAFFIGAN. And we can spend all the money we want on technologies, but that is not going to make the difference.

Chair BAIRD. Well, I am not sure of that. Doctor?

Dr. DER. I just wanted to follow up on the statement here. The climate change and greenhouse gas and CO_2 emissions is a global issue, and price signals that happen in the United States or Europe probably put certain technology out there at a certain cost. But in the developing economies who may not have certain price signals but continue to use coal, such as in China and India, they may not do that. They may, but at these additional costs today it is very expensive for us. It is overwhelmingly expensive for them. Therefore, I think the solution out of the box, if you will, really is these game-changing technologies that we need to work on to bring that cost down so that it is affordable not only by us, whether we have certain levels of the carbon valuation or not, but also in the developing countries and economies that are going to be growing and looking for a better standard of living.

Chair BAIRD. Mr. Inglis.

JOINING ENTREPRENEURS AND INVENTORS

Mr. INGLIS. Thank you, Mr. Chairman. This has been very helpful hearing particularly this last exchange about how do you get from here to there because, you know, what I think we should be aware of is until we do what we have just been talking about, which is attach a price, there would be no reason to go forward. We have great science projects, and we on the Science Committee love science projects. But until entrepreneurs and inventors are marrying each other because a price signal has been sent that now something is going to happen and you can make money doing it, you can make money solving this problem. Until that happens, nothing happens and we have hope but hope is not a strategy. And so what I particularly offer to Dr. Der to take back to the Administration is let us come up with something that works. As a conservative, I can tell you that there is very little chance that conservatives are going to vote for a cap-and-trade system. It is a massive tax increase, by itself is a massive tax increase. Also, in the aftermath of this financial downturn, do we really want to hand over to Wall Street traders some credits that they can trade? Maybe they can turn them into derivatives, and maybe we can do a bubble out of the derivatives and maybe we can see what a wild ride we get out of that.

So, not going to happen. There were 48 votes for cloture in the Senate this summer when it got tagged as a tax increase. In the midst of a downturn and with Wall Street looking like it looks, what is the chance of that number going north of 48? Answer? Not very much. So even if the House decides to run it through the House just on a cap-and-trade system, it is dead on arrival in the Senate. So if you really want to take action, you have got to find something better, and the collaborative opportunity that I think we have got is a revenue-neutral carbon tax if I may be so bold to suggest it, where you reduce payroll taxes and you apply a tax to carbon, a transparent, very clear price signal, very definitive price signal. You know exactly where we are going. Entrepreneurs and inventors know when to get married and when their technology can take out the incumbent technology, and it is an exciting opportunity, really, to bring the best of Republican thought, conservative thought, which is how markets work when they are properly adjusted. In other words, you have externalities recognized and attached to products, and the best of Democratic thought which has for a long time been, "we have got to do something."

So we put those two together and we got a solution that works, that actually can get through the House and maybe even through the Senate and it could get by and then we could get this energy revolution to happen like it happened, as I mentioned earlier, with the PC and the Internet.

So I am excited about the opportunity available to us if we would be able to collaborate. If we try to run this thing up the middle, up the middle punt series of plays, that is what we will end up with, a punt.

Chair BAIRD. That is called the Seattle Seahawks.

Mr. INGLIS. I went to Duke for college, and when we got frustrated in the stands, that is what we would cheer about the football team, up the middle, up the middle, up the middle, punt. And so you know, that is what we are facing if we try it just that sort of way. But if we think outside the box and we hear something that we can actually come together on and find a solution, I have been talking to the new Secretary about that. I think there is a real opportunity here, and I hope that this hearing helps speed it on. I went to making a speech there, Mr. Chairman, rather than asking a question.

Chair BAIRD. Let us ask the question. Can we ask our witnesses if they have some comments on Mr. Inglis' thoughts here?

Mr. GAFFIGAN. I would just wrap up and say that I think they are both important. I mean, I think technology plays a role, I think whatever signal we are going to send about carbon is important, and GAO recently did a study on the whole issue of climate change and talked to a lot of experts. They both agreed that both play a role, the R&D role and the sending the right signals or a signal of some kind that gives some certainty to folks. And they can't exist without each other.

Dr. FINLEY. I would just add one comment. I think the portfolio approach is important. Every aspect of efficiency, renewables, and carbon sequestration is necessary to get where we want to go, and I would note that Congress has passed some very significant mandates with respect to alternative fuels, biofuels, ethanol, and so forth. And from that fermentation process, you get a 99 percent pure stream of CO_2 and you avoid some of the costs that Mr. Monroe referred to. So let us do it incrementally. We can take pure CO_2 from a biofuel facility, and we can put it in the ground now and let us do that sooner rather than later while we reduce the cost of the parasitic load and the energy load on the power plants that Mr. Monroe referred to.

Mr. INGLIS. You know, it is very important, Dr. Finley, you just mentioned the mandates. That is one way to go. The challenge with that is it is not as elegant and efficient as a pure price signal because then competing technologies are out there in the private sector, and some of them will win and some of them will lose. If we from up here do a mandate, and I have voted for mandates, higher CAFE standards for example, but you don't get the innovation, the rapid innovation that you could get if you did it more elegantly by price signaling.

Dr. FINLEY. I would certainly agree with your point on that. The mandates are there and particularly as we move forward with, say, cellulosic or waste product ethanol type fuels rather than corn-to-ethanol or food-to-ethanol and avoid that fuel versus food debate, I think there is something to be gained there and given that those mandates were in place and presumably there are people out there making an effort to meet them.

Mr. MONROE. We would agree. We like flexibility there, so on one end is sort of the mandate to cap-and-trade somewhere in the middle. We get some flexibility under the cap, but where to do that? We like a pure price signal so that new innovations can come in. We don't have to go back to the regulatory sort of arena to sort of incorporate those and sort of like the way that spurs it so the company has a large research staff, and so we like really thinking out of the box, and that encourages it.

Chair BAIRD. Dr. Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman. First of all, let me say I will be happy to match our zero to 16 Detroit Lions against the Seattle Seahawks any day. We don't even go up the middle, we just throw interceptions. It is much more efficient.

Chair BAIRD. Let us hope our energy policy can exceed both of those records.

Mr. EHLERS. Absolutely. I also want to thank Mr. Inglis' comments. He is always very thoughtful on these issues, and he has thought deeply about them and what he says makes a lot of sense. I would say that part of the problem with the proposed cap-and-trade program, it is not even a cap-and-trade program, it is a simple tax, it is an energy tax, and that is why it is never going to fly. Cap-and-trade in a pure form might work once you get the markets going, but it is not going to be easy, but if you started out as a straight tax, I agree with you, it is destined to failure. But I think much of what you said is valid. I think, you know, the energy situation overall, over a 20-year period is so desperate that we really have to try every option possible and develop the best approach we can. And I think the marketplace is a good place to try many of the experiments. It gives you a fairly direct, fairly quick answer. So with that, I will yield back. Thank you.

Chair BAIRD. I will just observe that I think one of the ironies of the cap-and-trade debate has been that I think the cap-and-trade model was put forward as a way of trying to use conservative capitalistic values to justify investment in environmental protection and CO_2 reduction. So the incentive was there, and yet I think opponents of it are coming from the same side that it was designed to appeal to. And my own leaning is much more toward the line of Mr. Inglis. The only thing I would observe on that is it is easy to denigrate any form of tax because the indirect form, externalized form of tax government doesn't impose, nature imposes on it, and nature may actually impose a much higher rate of taxation in the form of consequences if we don't tax ourselves to try to reduce CO_2 and other gas emissions.

This has been a very, very informative discussion. We are very grateful for all of your time, and I thank very much my colleagues for their thoughtful input as well. And with that then, with the buzzing going off, the hearing will stand adjourned again with the gratitude of the Committee. Thank you very much.

[Whereupon, at 12:08 p.m., the Subcommittee was adjourned.]

Appendix 1:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Ms. Sarah M. Forbes, Senior Associate, Climate and Energy Program, World Resources Institute

Questions submitted by Chair Bart Gordon

Q1. Building a network of carbon capture and storage (CCS) demonstrations will require international collaboration. This makes sense to ensure that CCS demonstrations around the globe are diverse and demonstrate the full suite of capture and storage options. In your view, how do we best accomplish this? Is there a specific federal agency best equipped to take the lead on international collaboration on CCS demonstrations?

A1. The U.S. Department of Energy's Carbon Sequestration Leadership Forum (CSLF) includes the right structure for a global network of carbon dioxide capture and storage (CCS) demonstrations. It benefits from ministerial-level support and includes key coal-consuming countries; however, global interest and action on CCS has quickly advanced and the existing framework must be updated and formally endorsed by Congress. The following actions are needed to leverage the past activities of the CSLF and move toward new mechanisms that facilitate successful international collaboration:

- Establish a CCS demonstration technology alliance for countries working on demonstrations, whereby a formal network is established to share information among projects and ensure that information is publicly available. This should be a new initiative, led by the Energy Department, building on the success of CSLF activities and including the CSLF member countries. It should be launched in collaboration with the Australian-led Global Carbon Capture and Storage Institute and possibly the International Energy Agency.
- Increase the number of full time technical staff devoted to international CCS collaboration within the Department of Energy's Office of Fossil Energy. This allocation can ensure that existing bilateral agreements result in concrete actions and that activities are scientifically and technically robust. This technical group should be adequately funded and given a high priority.
- Establish a multi-agency task force to steer international CCS collaborations and advise the CCS Technology Demonstration Alliance. The task force should be led by the Energy Department, but also include participation from the Department of State, the Environmental Protection Agency, and Treasury Department. The task force should meet quarterly.

Q2. In your testimony, you mention that moving forward with CCS worldwide will require significant investment. What actions would you recommend the Federal Government should take to ensure that a clear and robust international financing mechanism exists for large-scale CCS demonstration projects?

A2. Governments worldwide are moving toward CCS demonstration by committing funding to demonstrations. Within the past month, requests for proposals for CCS demonstrations have been made by the European Commission[1] and the U.S. Department of Energy[2] as part of the recently passed stimulus packages at EUR 1.05B and USD 2.4B, respectively. Australia's budget discussions[3] have also included discussion of allocating AUD 2B toward 2–4 CCS demonstrations, and the UK's Energy Secretary announced a plan to subsidize four demonstrations.[4] Although this funding is significant, there is (1) a lack of funding dedicated to demonstrations of CCS at commercial scales in the U.S., (2) insufficient funding globally to achieve the goal of 20 demonstrations worldwide, and (3) barriers to obtaining public and private sector investment in the technology that must be overcome to achieve demonstrations and supplement government subsidies.

Specific actions this committee could take to provide clarity toward public and private sector investment and international collaboration on demonstrations include:

- Develop a multi-agency task force to study and formally recommend international CCS financing mechanisms. The task force should include participa-

[1] *http://ec.europa.eu/energy/grants/2009_07_15_en.htm*
[2] *http://www.energy.gov/news2009/7405.htm*
[3] *http://www.news.com.au/business/story/0,23636,25470205-31037,00.html?from=public_rss*
[4] *http://www.cnplus.co.uk/sectors/energy/miliband-no-new-coal-power-stations-without-carboncapture/5200978.article*

tion from the State Department, Department of Energy, the Environmental Protection Agency, and Treasury Department.

- Request that this task force prepare (within 120 days) a report to Congress on international financing mechanisms for CCS that provide clear recommendations on international government funding (consider pairing/twinning or co-funding demonstration projects with other countries), outlines the role of multilateral banks, and presents solutions to the obstacles to private-sector investment in CCS.

Appendix 2:

ADDITIONAL MATERIAL FOR THE RECORD

The Passing of FutureGen: How the World's Premier Clean Coal Technology Project Came to be Abandoned by the Department of Energy

REPORT BY THE MAJORITY STAFF OF THE SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY TO CHAIRMAN BART GORDON AND SUBCOMMITTEE CHAIRMAN BRAD MILLER

MARCH 10, 2009

Executive Summary

When President George W. Bush announced the FutureGen initiative in February of 2003, he described it as a 10-year, $1 billion, government/private partnership to build a coal-based, zero-emissions electricity and hydrogen producing power plant. It would provide the American people and the world with advanced technologies that would help meet the world's energy needs, and would improve the global environment for future generations. Spencer Abraham, then-Secretary of the Department of Energy (DOE), went even further. This "bold step" would turn coal from an "environmentally challenging energy resource into an environmentally benign one" and demonstrate the best technologies the world had to offer.

The plant would not use traditional coal technology, but would be an integrated gasification combined cycle/carbon capture and storage (IGCC/CCS) facility built at the commercial scale of 275 megawatts. It would sequester one million metric tons of carbon dioxide per year, produce both electricity and hydrogen as energy sources and demonstrate the integration of commercial and untested technologies. Its results would be shared with all participants, including international parties, industry, the environmental community and the public. International participation was a core component of the project as acceptance of the project's results were deemed necessary by the Administration for building an international consensus on the role of coal and carbon sequestration in addressing global climate change and energy security.

But in December of 2007, after a site in Illinois was selected by FutureGen's private industrial partners, the environmental impact statement required by the *National Environmental Policy Act* was completed, and the State of Illinois had accepted liability for the sequestration aspect of the project, then-DOE Secretary Samuel Bodman announced that he intended to restructure FutureGen. He would "maximize" the private sector role and prevent further cost escalation. The restructured FutureGen was rolled out at the end of January of 2008, but it was widely viewed as the death of the Bush initiative. Subsequent events have verified that view, as the four applications—two of which have been deemed ineligible—responding to the new competition bear no resemblance to the original FutureGen and have no capability to meet the original goals.

How did such a highly publicized Presidential initiative fail, and what were its consequences? Committee staff review of thousands of documents produced by the Department of Energy over the past several months[1] has resulted in the following conclusions:

1. Based on how easily the Department of Energy abandoned the FutureGen project, it appears that President Bush, Secretary Bodman and the Office of Management and Budget were never fully committed to the FutureGen project or its goal of developing technology to allow the use of coal without massive emissions of carbon dioxide and other greenhouse gases and pollutants. In retrospect, FutureGen appears to have been nothing more than a public relations ploy for Bush Adminis-

[1] DOE was extremely reluctant to produce documents to the Committee so that it could determine exactly how decisions were made concerning FutureGen. Despite numerous requests from the Committee since April 2, 2008, and the threat of a subpoena, the Department has still not yet provided a full response. Many of the withheld documents involve communications with the White House and this situation has required repeated meetings to examine those materials. We should add that Undersecretary Albright routinely destroyed his e-mail records, further complicating the ability of the staff to reconstruct the full history on decision-making regarding FutureGen.

tration officials to make it appear to the public and the world that the United States was doing something to address global warming despite its refusal to ratify the Kyoto Protocol.[2] When worldwide construction costs went up across the board, neither the White House nor DOE was willing to make the additional financial commitment necessary to keep the project going. Secretary Bodman, in particular, strongly disliked FutureGen, and neither President Bush nor any of his White House staff did anything to stop Bodman from killing the original project or restructuring it in a way that was guaranteed to fail. As an assistant to Under Secretary Bud Albright put it during a discussion of restructuring FutureGen:

> "[E]veryone is conveniently forgetting that we're here b/c [because] S–1 [Secretary Bodman] wants to kill FG as its [sic] currently contemplated with or without a Plan B." [3]

2. Bodman's primary stated reason for killing the original FutureGen plan was that the cost had doubled to $1.8 billion. That was false, and an inexcusable error for the head of a federal agency. Bodman and his staff obtained that number by comparing the cost estimate of $952 million in constant FY 2004 dollars with the "as spent" dollars—which is always higher because it includes normal inflation and other cost increases—that all federal agencies use when estimating the actual cost of multi-year projects such as FutureGen. The Office of Fossil Energy attempted numerous times to explain to DOE's policy staff the difference between these two numbers, but as Under Secretary Bud Albright's Chief of Staff cavalierly explained while preparing talking points for Bodman, "this is not a legal document, it is a communications document. As for whether the escalation costs after 2004 were expected or not, why does that even matter?" [4]

It is difficult to believe that anyone working at the top levels of DOE or the White House, both of which deal with many multi-year clean-up, research and defense projects—particularly someone with Bodman's business background—did not know the difference between "constant" and "as spent" dollars or even ask how the $1.8 billion figure was obtained. But there is no evidence that anyone asked that basic question.

3. Secretary Bodman should have known that his claims that the restructured FutureGen would accomplish all of the goals of the original plan and would speed the use of CCS technology were false Bodman and his senior deputies—Deputy Secretary Clay Sell and Under Secretary Albright—demanded that DOE staff create documents for the White House saying the new plan would cost less taxpayer money and do more to validate new carbon capture and sequestration technologies in a shorter time frame than the original FutureGen. This work was largely overseen by political appointees working under Sell and Albright. These claims were concocted without consulting the industry that was expected to take up the FutureGen mantle and despite the repeated warnings of career DOE staff to the political leadership of the Department that the project would fail to meet the original goals. Career staff produced a summary analysis by December 2007 that was entitled, *"What "Plan B" would NOT accomplish"* (emphasis in original). The concluding paragraphs are so compelling that they are worth quoting at length:

> Given the above delays [following analysis of how Plan B would slow technology development and deployment], it is reasonable to assume that proceeding with "Plan B" and without FutureGen, the availability of affordable coal fueled CCS plants would be delayed at least 10 years and will not allow widespread deployment of CCS until near 2040. Affordable CCS technologies will not be available in time to meet the expected turnover of the existing fleet of coal power plants in the U.S., nor for incorporation into the development of the world's massive coal resources in countries such as China and India.
>
> Based on the DOE Climate Change Task Force analysis, which was the basis for the FY09 DOE budget request, a delay of ten years in the deployment of fossil technology with CCS would result in a cumulative loss of emission reductions of about 22 billion tons CO_2 through 2100 in the U.S. To put this into perspective, current U.S. total annual CO_2 emissions are six billion tons; U.S.

[2] FutureGen was touted as a key climate change inspired action to the Committee on Science in a hearing on September 20, 2006, "Department of Energy's Plan for Climate Change Technology Programs." The Departmental witness stated that "CCTP's portfolio includes realigned activities as well as new initiatives, such as the President's Advanced Energy and Hydrogen Fuel Initiatives, carbon sequestration, and FutureGen," p. 21.

[3] E-mail from Doug Schwartz to Julie Ruggiero, December 10, 2007.

[4] E-mail entitled "Fw: Updated FuturrGen Talking Points" from Doug Schwartz to Andrew Patterson, Dec. 15, 2007.

annual CO_2 emissions from coal are two billion tons. The DOE Task Force further estimated that CCS benefits from the proposed initiative for the rest of the world were about six times the U.S. benefits, or on the order of 150 billion tons CO_2 through 2100 worldwide that would not be avoided if "Plan B" were chosen.[5]

4. The anemic response by industry to the competition to participate in the new FutureGen proved in a real world demonstration how wrong Bodman and his deputies were. There were four responses of which two were ineligible and two were incomplete. None proposed to construct the IGCC/CCS, coal-based, zero-emission electricity and hydrogen producing power plant that had been promised by Secretary Bodman in January of 2008. The industry response to a Request for Information and the draft FOA had reduced the restructured program to a competition for technology that would attempt to sequester a smaller amount of carbon dioxide, either as part of a newly constructed plant or as a "bolt on" to an existing plant.

But by the time the career staff were proven right, Bodman and President Bush were at the end of their tenure, the scheduled project selection date had passed, and the United States had lost a year, at minimum, in developing and deploying carbon capture and sequestration technologies.

5. The Bush Administration's abrupt cancellation of the original FutureGen without bothering to consult or even warn the four countries (India, Australia, South Korea, and China) which had signed on as project partners severely damaged the United States' reputation as an international science partner. The South Korean Minister for Commerce, Industry and Energy wrote on February 4, 2008 (three days after receiving a cancellation notice from Secretary Bodman):

> "I am really surprised that I had no prior explanation of that restructuring intention from DOE . . .. If you have recognized all Korea's endeavor regarding the project, it is not the appropriate way to deliver U.S. DOE's intention to restructure FutureGen by sending me an e-mail."[6]

Foreign partners weren't the only ones surprised by DOE's change of direction. Cancellation of the project, and the abandonment of the growing coalition of countries supporting the project, also allowed the technology lead in this important endeavor to move to other countries. Carbon capture and sequestration projects are now going forward in Australia, China (former partners) and Europe. Other countries no longer look to the United States for leadership in this area, and, as senior DOE officials acknowledged to one another, the restructured program had no international component built into it.[7]

6. Creating "clean coal" is an extremely complex task involving not only the development of reliable and economical technology to capture carbon dioxide and other pollutants, and integrating it into electricity-producing coal plants, but also the acceptance of higher electricity prices and unknown liability for carbon dioxide sequestration sites by the public and their elected officials worldwide. Without a carbon regulation structure in place, it is almost impossible to expect power generators and utilities to take on this "public benefit" task without expecting a return on investment, something that the Bush Administration refused to acknowledge, much less address. This guaranteed that Secretary Bodman's efforts during the summer and autumn of 2007 to convince industry to sign up for more risk in the original FutureGen project would be a non-starter. FutureGen was a high-risk effort to develop and demonstrate innovative technologies for carbon capture and sequestration. Without a regulatory environment requiring firms to use such technologies, there was little reason—beyond calculations of public relations—for private companies to commit any more than they already had on FutureGen.

When the Department of Energy's top managers were attempting to restructure FutureGen, a senior career official from the Office of Fossil Energy described the new project as a Frankenstein.[8] The analogy to the creation of a monster which

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[5] Analysis from a one page document drawn from e-mails circulating in the Department dated December 11, 2007. These findings were also quoted by Victor Der in an e-mail that went to James Slutz and others in this same time frame, but similar points had been raised by DOE staff throughout the discussion of whether there was a viable option to the President's FutureGen program.

[6] E-mail entitled "Re: DOE Announces Restructured FutureGen" from Kijune Kim to James Slutz, Feb. 4, 2008.

[7] E-mail entitled "RE: Int'l aspect of the new futuregen construct" from James Slutz to Karen Harbert, Dec. 12, 2007.

[8] E-mail from Victor Der to Jay Hoffman and Jarad Daniels, January 2, 2008 forwarding the Plan B Program Plan. Der writes in full: "Here's the Frankenstein. I'll be calling NETL [Na-

could not be controlled by its creator was not quite accurate. But the idea that "Plan B" was a cobbled together mess of left-over parts was not far off the mark. However, what DOE really created was more of a Humpty Dumpty. Just like Humpty Dumpty, when FutureGen fell off the wall in its "restructured" form, it broke apart, and all of DOE's press releases and PowerPoint presentations couldn't put it back together again.[9]

The Origins of FutureGen

In his State of the Union address in January of 2003, President George W. Bush unveiled his "Hydrogen Fuels Initiative," otherwise known as a hydrogen-powered, noxious emissions-free car called the "Freedom Car." He committed $1.7 billion over the next 10 years for research on car technology and fuel distribution. But where would the hydrogen fuel come from? In the volume required by the transportation sector, it could only come from coal or natural gas.[10] And thus was born FutureGen.

A month later, on February 27, 2003, the President announced with great fanfare the Integrated Sequestration and Hydrogen Research Initiative, a 10-year, $1 billion, government/private partnership to build a coal-based, zero-emissions electricity and hydrogen producing power plant. "This demonstration project and the Carbon Sequestration Leadership Forum will build on these initiatives to provide the American people and the world with advanced technologies to meet the world's energy needs, while improving our global environment for future generations," he promised.[11] "It will be the cleanest fossil fuel-fired power plant in the world," a contemporaneous Department of Energy (DOE) publication claimed and was a "direct response to the President's Climate Change and Hydrogen Fuels Initiatives."[12] According to then-DOE Secretary Spencer Abraham, the project would "help turn coal from an environmentally challenging energy resource into an environmentally benign one."[13] It would be "one of the boldest steps our nation has taken toward a pollution-free energy future . . .. The prototype power plant will serve as the test bed for demonstrating the best technologies the world has to offer," Abraham promised.[14]

The announcement was made jointly by the Department of Energy (DOE) and the Department of State to emphasize the core objective of international cooperation. At the same time, the two agencies announced the creation of the Carbon Sequestration Leadership Forum (CSLF), an international panel which would focus on carbon capture and sequestration.[15] All these initiatives were in large part a response to President Bush's desire to show that the United States was engaged in efforts to reduce global warming even though it had refused to ratify the Kyoto Protocol because of the generous greenhouse gas emission limits for developing countries. They were hailed by the business press as a "viable alternative to Kyoto."[16]

The 275-megawatt, prototype zero emissions plant subsequently known as "FutureGen" would be a "living laboratory" to test new clean power, carbon capture and coal-to-hydrogen technologies. The DOE release went on to say that President Bush had already emphasized the importance of technology in stabilizing greenhouse gas concentrations in the atmosphere with two major previous policy announcements: the National Climate Change Technology Initiative on June 11, 2001, and the Global Climate Change Initiative on February 13, 2002. "Carbon capture and sequestration technologies likely will be essential to meeting the President's goals. Without them, it will be virtually impossible to limit global carbon emissions," DOE stated.

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tional Energy Technology Laboratory] to see where they are in the electrodes development to make it walk."

[9] Humpty Dumpty's ability to create new meanings for words in Lewis Carroll's *Through the Looking Glass* also bears some relationship to Secretary Bodman's attempt to create something new while still calling it "FutureGen" so that, technically, he could say the President's initiative was alive. "When I use a word," Humpty Dumpty said in a rather a scornful tone, "it means just what I choose it to mean—neither more nor less." "The question is," said Alice, "whether you can make words mean different things." "The question is," replied Humpty Dumpty, "which is to be master—that's all."a

[10] "A Car for the Distant Future," *The Washington Post,* March 9, 2003, B2.

[11] "Bush Administration Announces $1 Billion Coal Plant Project," *Platts Coal Outlook,* March 3, 2003, p. 1.

[12] "A Vision for Tomorrow's Clean Energy," U.S. Department of Energy, Office of Fossil Energy, February 2003, p. 1.

[13] "U.S. Seeking Cleaner Model of Coal Plant," *New York Times,* Feb. 28, 2003, A22.

[14] "DOE Aims for 'pollution-free' Plant," *Inside Energy/Federal Lands,* March 3, 2003, p. 1.

[15] DOE, "Concept Paper on International Participation in FutureGen," June 2008.

[16] "The Post-Kyoto Initiatives," *http://www.allbusiness.com/mining/oil-gas-extraction-crude-petroleum-natural/718535-1.html*, Dec. 22, 2003.

Moreover, the President's Hydrogen Fuels Initiative envisioned "the ultimate transformation of the Nation's transportation fleet from a reliance on petroleum to the use of clean-burning hydrogen," DOE said. Although most hydrogen in the United States and about half of the world's hydrogen supply were currently produced from natural gas, *"The new technologies to be integrated into the prototype plant will expand the options for producing hydrogen from coal, providing a more diversified and secure source of feedstocks for the President's initiative"* (emphasis added).[17]

Virtually every aspect of the prototype plant would employ cutting-edge technology. It would not use "traditional coal technology," but be based on a coal gasification system to produce hydrogen and carbon dioxide. The hydrogen would be used for electric power generation or as a feedstock for refineries. "In the future, as hydrogen-power automobiles and trucks are developed as part of President Bush's Hydrogen Fuels Initiative, the plant could be a source of transportation-grade hydrogen fuel." New technologies would be used to capture the carbon dioxide, and it would be sequestered in a geologic formation that would be intensively monitored to verify the permanence of the storage.[18]

The goals of the project were extremely ambitious. DOE and its partners were to:

1. Design, construct and operate a 275-megawatt prototype plant that produced electricity and hydrogen with near-zero emissions. The size of the plant was driven by a need to provide commercially relevant data and produce one million tons of carbon dioxide (CO_2) necessary to validate the "integrated operation of the gasification plant and the receiving geologic formation."

2. Sequester at least 90 percent of the CO_2 emissions, prove the effectiveness, safety and permanence of the sequestration and establish standardized technologies and protocols for CO_2 measuring, monitoring and verification.

3. Validate the engineering, economic and environmental viability of "advanced coal-based, near-zero emission technologies" that by 2020 would produce electricity with less than a 10 percent increase in cost; and produce hydrogen at $4 per million Btus or less than the wholesale price of gasoline.[19]

The industry and the environmental community expressed skepticism from the outset. Coal gasification to produce electricity is "still an edgy technology," one expert said, and extracting hydrogen from coal wasted 30 percent of the fuel's latent energy. The budget and schedule were viewed as tight "even for a conventional coal-fired power plant." One environmentalist said until the administration supported a "binding program" to limit carbon emissions, the private sector would not commit "real money" to solving the problem.[20] But if the project reduced the cost of carbon dioxide sequestration from $100 to $300 per ton to $10 or less, it would save the U.S. "trillions of dollars" to meet the inevitable carbon regulations.[21]

By the end of 2003, DOE's Office of Fossil Energy (FE), which had the lead on the project, had prepared the mission need statement required for the acquisition of a capital asset. It focused on the necessity to integrate the operation of a coal-based hydrogen/power facility with carbon dioxide sequestration, something that the existing clean coal research program—which addressed the development of components and subsystems—did not do. To sufficiently consider the feasibility of the zero-emissions concept, DOE had to address the integration gap "to prove technical operational viability to the conservative coal and utility industry."[22] The expectation was that FutureGen would be sufficiently successful that when the aging fleet of coal plants was retired in the 2020–2040 time frame, there would be a viable zero emissions coal option.[23]

In the need statement, FE evaluated and rejected six alternative approaches to achieve President Bush's goal. In particular, it rejected the option of a large-scale demonstration of commercial technology by the power industry. "This alternative would require the immediate integration of a number of complex commercial-scale

[17] All discussion of "DOE Release" is from "A Vision for Tomorrow's Clean Energy," U.S. Department of Energy, *supra.* p 1. President Bush reiterated his support for FutureGen in fact sheets and statements related to his administration's environmental and energy accomplishments in October 2003, April 2004, March and June 2005, February and March of 2006, and January, April, May and September of 2007. New foreign partners were welcomed at the White House. "Statements about FutureGEN," undated DOE document.

[18] *Ibid.*

[19] "A Vision for Tomorrow's Clean Energy," *supra,* p. 2.

[20] *Ibid.*

[21] "A Pollution-free Coal Plant?" *Power Magazine,* May 2003.

[22] "Mission Need Statement: FutureGen Sequestration and Hydrogen Research Plant," DOE Office of Fossil Energy, Nov. 6, 2003, pp. 1–2.

[23] *Ibid., p. 4.*

power plant component technologies, and operation and integration will be technically challenging and risky from an industry perspective." Moreover, the sequestration had not yet been demonstrated. Such an approach would not be cost-effective and without legislated carbon constraints, "the industry has no incentive to invest its limited capital in this demonstration and pursue this high-risk course of action."[24]

The acquisition strategy for a research and development project was conditionally approved by DOE's deputy and undersecretaries in November of 2003 and fully approved in April of 2004. Congress provided $9 million to initiate FutureGen, but also asked for a report on funding and cost sharing.[25] The goals and the Administration's plans for achieving them were more fully outlined in the program plan submitted to Congress in March of 2004 as required in the *Department of Interior and Related Agencies Appropriation Act of 2004* (P.L. 108–108). The cost share would be 74 percent government and 26 percent private—well above the 20 percent commitment from the private sector normally required for research and development projects.[26]

In the plan, DOE told Congress that FutureGen "directly" addresses one of the four strategic goals in its 2003 Strategic Plan: to protect national and economic security by "promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy." Through use of efficient generation technologies and carbon sequestration, FutureGen would eliminate environmental barriers and enable the continued use of domestic coal. It would also produce hydrogen for transportation to support President Bush's hydrogen fuel initiative and provide a "unique real-world opportunity to prove the feasibility of large-scale carbon sequestration, a key potential strategy to reduce the risks of climate change." Absent this "zero-emission option . . ., coal's contribution to the Nation's energy mix could be severely curtailed, thus limiting the fuel diversity of our electricity supply portfolio, and increasing our dependence on more expensive and less secure sources of energy."[27]

Defined as a "public benefits-driven" investment in "high-risk, high-return technology that private companies alone cannot undertake" FutureGen's integration of concepts and components would be the

> key to proving technical and operational viability to the generally conservative, risk-adverse coal and utility industries. Integration issues such as the dynamics between upstream and downstream subsystems . . . can only be addressed by a large-scale integrated facility operation. *Unless the production of hydrogen and electricity from coal integrated with sequestering carbon dioxide can be shown to be feasible and cost competitive, the coal industry will not make the investments necessary to fully realize the potential energy security and economic benefits of this plentiful, domestic energy resource* (emphasis added).

FutureGen would combine high-risk research activities, advanced generation coal gasification technology integrated with combined cycle electricity generation, hydrogen production, and carbon capture and sequestration. It would take at least 10 years to accomplish its goals, and the results would be shared with participants, industry, the environmental community, international partners and the public. "Broad engagement of stakeholders early on in FutureGen is critical to achieving an understanding and acceptance of sequestration and zero-emission coal utilization," DOE stated.[28]

While its goals and schedule were recognized as aggressive and high-risk, they were judged achievable and would prove "the basis for a potentially huge long-term public benefit." And DOE determined that it was not possible "to reach FutureGen's stretch goals using off-the-shelf commercial technology." Critical components needed to be designed, and their efficiencies, environmental performance reliability and economics needed to be advanced and tested. More importantly, "[a] key piece of FutureGen is proving the viability of sequestration and its integration with a power

[24] *Ibid.,* pp. 12–13.
[25] E-mail entitled "RE: FW: FutureGen Acq Strategy" from Keith Miles to Patrick Ferraro, Feb. 27, 2007.
[26] DOE, Office of Fossil Energy, "FutureGen: Integrated Hydrogen, Electric Power Production and Carbon Sequestration Research Initiative: Energy Independence through Carbon Sequestration and Hydrogen from Coal," March 2004; Conf. Rep. 108–330, 149 *Cong. Rec.* 9898, 9936, Oct. 28, 2003.
[27] DOE, "FutureGen: Integrated Hydrogen, Electric Power Product ion and Carbon Sequestration Research Initiative," *supra,* p. 2.
[28] *Ibid.,* p. 3

facility." [29] Full-scale operation with continuous power generation was projected by FY 2012.[30]

Furthermore, according to White House officials, the hydrogen transportation initiative and FutureGen were investments that would achieve "both goals of addressing climate change and protecting our economy." [31]

In 2005, after *The New York Times* alleged that industry would not spend money to reduce emissions under a voluntary system that gave a competitive advantage to those companies that did nothing, Samuel Bodman, the new DOE Secretary, reiterated the Department's support for FutureGen.[32] President Bush also featured it prominently in a 2005 "fact sheet" concerning how he was addressing climate change. In December of 2005, Bodman announced an agreement with an industry consortium called the FutureGen Industrial Alliance, to build FutureGen, "a prototype of the fossil-fueled power plant of the future." He described it as a direct response to President Bush's directive to develop a hydrogen economy by "drawing on the best scientific research to address the issue of global climate change." Bodman lavishly praised the Alliance members, who would contribute $250 million to the project, as among "the world's most responsible and forward thinking coal and energy companies." At the heart of the project—described as a "stepping-stone toward future coal-fired power plants"—would be coal-gasification technologies that could eliminate air pollutants and mercury. Carbon sequestration would be a key feature with the goal of capturing 90 percent of the plant's carbon dioxide emissions. The "ultimate goal for the FutureGen plant is to show how new technology can eliminate environmental concerns over the future use of coal and allow the Nation to tape the full potential of its coal reserves," Bodman said.[33]

By January of 2006, the project now known as FutureGen was no longer being promoted as a source of transportation-grade fuels, perhaps because the Administration had realized that commercially viable hydrogen-powered cars were some decades away.[34] FutureGen was now to integrate advanced coal gasification technology, hydrogen from coal, power generation, and carbon dioxide (CO_2) capture and geologic storage. "The success of FutureGen will assure that coal, a low-cost, abundant, and geographically diverse energy resource, continues to globally supply exceptionally clean energy." [35]

The project appeared to be going well in this time frame—at least publicly. A preliminary agreement with the Alliance was signed on December 2, 2005.[36] President Bush referred to it in his 2006 State of the Union address as part of his Advanced Energy Initiative.[37] Participation by foreign governments was expected.[38] Its cost in FY 2005 constant dollars was $952 million.[39] According to DOE's Assistant Sec-

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[29] *Ibid.,* p. 6.

[30] *Ibid.,* p. 13.

[31] Statement of James Connaughton at Oct. 22, 2004, "Ask the White House," *http://georgewbush-whitehouse.archives.gov/ask/20041022.html*

[32] "Climate Change and the President," letter from Secretary Bodman, *The New York Times,* May 26, 2005, responding to "Dirty Secret: Coal Plants Could Be Much Cleaner," May 22, 2005. That article referred to the recommendation of the National Commission on Energy Policy, an independent, bipartisan advisory body that the government spend an additional $4 billion on IGCC technology over 10 years to speed up the industry's acceptance of the technology.

[33] "FutureGen Project Launched: Government, Industry Agree to Build Zero-Emissions Power Plant of the Future," DOE press release, Dec. 6, 2005. There were ultimately 13 industrial partners of which four were foreign-based: American Electric Power Service Corp., Anglo American Services Ltd., BHP Billiton Energy Coal, Inc., China Huaneng Group, Consol Energy, Inc., E.ON U.S. LLC, Foundation Coal Corp., Luminant, Peabody Energy Corp., PPL Energy Services Group, Rio Tinto Energy America Services, Southern Company Services, Inc., and Xstrata Coal Pty Ltd.

[34] "When Presidents Talk Fuel, the Nation Listens, Sort Of," *Detroit Free Press,* Feb. 13, 2006, B2.

[35] DOE, "FutureGen—A Sequestration and Hydrogen Research Initiative," Project Update: January 2006."

[36] DOE, "FutureGen Status," PowerPoint presentation for 7th annual SECA Workshop and Peer Review, Sept. 12–14, 2006.

[37] In a press release providing a more detailed description of the initiative, the Administration noted that the 2007 budget included $54 million for FutureGen as part of the clean coal technology program. The White House, "State of the Union: The Advanced Energy Initiative," Jan. 31, 2006, p. 1.

[38] British, Australian and Chinese companies were already Alliance members. *http://www.futuregenalliance.org/alliance/members.stm* Four countries (India, Korea, Japan and China) also joined.

[39] Constant dollars are not an accurate reflection of the actual cost of a 10-year, lifetime project over the life of the project because they do not include cost increases that result from inflation and changes in construction, materials and other costs during the out-years. In its 2004 report to Congress, DOE did not point out that it was using constant year dollars when pro-

retary for fossil energy, "the FutureGen project is being pursued aggressively and is on schedule."[40] It was a "high priority," James Connaughton, Chairman of the White House Council on Environmental Quality and the President's senior environmental and natural resources adviser, stated in late 2006.[41] By April of 2007, a first phase cooperative agreement had been signed which would include work on siting, scoping, conceptual design and *National Environmental Policy Act* (NEPA) compliance. The Alliance had selected four sites as finalists, and the winning site was expected to be announced in mid- to late 2007.[42]

The significance of the FutureGen project on the international stage could not be underestimated. After his refusal to submit the Kyoto Protocol to the Senate for ratification, President Bush and his advisers touted the highly visible project as a way to attack the problem of global warming in the voluntary, cooperative international manner that was a hallmark of the Bush approach to environmental problems. CEQ Chairman Connaughton, who had the task of defending the Bush Administration, did so by promoting international partnerships for sustainable growth, of which FutureGen was one.[43] It was particularly important in U.S. relationships with India and China, both of which signed on as partners in the FutureGen project even before the cooperative agreement with the Alliance was completed. A "U.S.-India Energy Dialogue" was established by Secretary Bodman and Montek Singh Ahluwalia, Deputy Chairman of India's Planning Commission, in 2005. By May of 2006, India had become the first foreign country to sign on as a FutureGen partner. According to Senate testimony in 2007 by David Pumphrey, then DOE Deputy Assistant Secretary for international energy cooperation, "successfully demonstrating and adopting this technology will allow India to reduce the intensity of future greenhouse gas emissions from the burning of their abundant coal resources."[44]

In September of 2006, President Bush and President Hu Jintao of China agreed to create a "Strategic Economic Dialogue" (SED) between the two countries which would be convened semi-annually. Treasury Secretary Henry Paulson would lead the U.S. side of the dialogue, and the Energy Department would dialogue with China's National Development and Reform Commission on energy policy.[45] In December of 2006, China—the second largest producer of CO_2 after the U.S.—became the third foreign country (South Korea was the second) to join the FutureGen Government Steering Committee. China Huaneng Group, the country's largest coal-fueled power generator, had already joined the Alliance. According to Pumphrey, the U.S. "assigned a high priority to maintaining long-term technical cooperation with China on fossil energy issues," including FutureGen. The FutureGen concept could demonstrate technologies that would reduce carbon emissions worldwide.[46]

The Cost Issue

By early 2007, however, DOE management internally was raising questions about the cost of FutureGen. Even before the Full Scope Cooperative Agreement was signed, DOE headquarters was expressing its discontent to the Alliance. FutureGen's as-spent cost projection, which included inflation and the increasing cost of construction and materials, was $1.8 billion and global construction costs were rising. In light of those anticipated cost increases, DOE was balking at paying 74 percent of any additional costs even though an increase in as-spent costs would normally be expected. Michael Mudd, the Alliance's Chief Executive Officer, expressed his concern about DOE's delay in signing the cooperative agreement, saying it would cause schedule and engineering delays and a loss of credibility. "We do not understand why issues, such as the cost-share fraction, continue to be revisited. This specific issue was settled nearly two years ago during discussions between the White House, OMB, DOE, and the Alliance." The Alliance would like to report "posi-

jecting the total cost of the project. DOE, "FutureGen: Integrated Hydrogen, Electric Power Production and Carbon Sequestration Research Initiative, *supra,* p. 9, Figure 3.

[40] "Clean Energy Project," letter from Jeffrey Jarrett, *The New York Times,* June 5, 2006.

[41] "Budgets Falling in Race to Fight Global Warming," *The New York Times,* Oct. 30, 2006, A1.

[42] *Ibid.,* p. 2.

[43] "Bush Aide Says Myths about U.S.' Green Policy Remain," *The Economic Times,* Aug. 30, 2006.

[44] Statement of David Pumphrey before the U.S. Senate Committee on Energy and Natural Resources, July 18, 2006, p. 4.

[45] "Fact Sheet Creation of the U.S.-China Strategic Economic Dialogue," Treasury Department press release, Sept. 20, 2006.

[46] "U.S.-China Relationship: Economics and Security in Perspective," Statement by David L. Pumphrey before the U.S.-China Economic and Security Review Commission, Feb. 1, 2007, p. 7.

tive progress" on all fronts to Congress "rather than concerns that the Administration is having second thoughts about supporting the FutureGen project."[47]

In a discussion over a draft press release announcing the agreement, Victor Der, then-Director of DOE's Office of Clean Coal Systems,[48] complained to George Rudins, former Deputy Assistant Secretary for coal and power systems, that the release emphasized a cost increase, not the fact that "notwithstanding rising inflation in the heavy construction sector, both the Alliance and DOE believe that FutureGen is vitally important to coal and climate change, and have committed to continuing as cost shared partners in this initiative."[49] FE also reminded the Department that it was a "key Presidential Initiative and a major Government/Industry Partnership" for producing electricity and hydrogen from coal while eliminating emissions and sequestering carbon dioxide at a low cost.[50] The final press release did, however, refer specifically to the cost increases, but said a review of "progress and expenses" would not be concluded until the end of the first phase of the project in June of 2008.[51]

The Alliance was so upset by DOE's concerns as expressed in a call from Deputy Secretary Clay Sell on the day the press release was issued that Mudd said it was "putting the project on hold until we have the chance to meet with Clay and Secretary Bodman to address issues and concerns raised by Clay during his call."[52] When asked later in a press call why DOE signed the agreement if it already had these concerns, Sell said it was the signing of the agreement that brought the financial issues to his and Secretary Bodman's attention.[53]

Sell and Bodman did not waste any time bringing their hesitation to the White House. In April, Sell briefed staff of the National Economic Council, OMB, the National Security Council and the Office of the Vice President on their cost concerns, and it was agreed that the costs had to be capped.[54] Thomas Shope, DOE's principal Deputy Assistant Secretary for fossil energy, communicated to the Alliance that "the project will not move forward as currently structured." Within days, DOE's lawyers were asked to determine if the agreement made clear that DOE could "just decide not to fund it if it got too expensive" or how to cap its contribution.[55]

At a May 11, 2007, meeting with NEC and OMB staff, Shope recorded the following:

> DECISIONS: The significance of the project in the Administration's global climate change strategy was recognized. However, additional cost containment measures must be part of the project going forward and must be negotiated before the commencement of BP–2. The principal cost containment measure employed will be a cap on DOE's expenditures.[56]

The $1.8 billion as-spent figure had been obtained by adding a straight-line 5.2 percent annual escalation factor during the construction of the contract to the FY 2004 estimate of $950 million, a normal process for all large projects built over a number of years. The Alliance then subtracted $301 million in estimated income from the sale of electricity to come up with a net cost of $1.46 billion. FE staff accepted that as a reasonable escalation, but construction costs in early 2007 were growing at a much higher rate because of worldwide demand for construction services and materials.[57]

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[47] E-mail entitled "FutureGen delays," from Michael Mudd to George Rudins (cc: Carl Bauer, Keith Miles, Thomas Russial, Thomas Sarkus) March 20, 2007.

[48] Dr. Der has held various positions at DOE related to fossil energy and clean coal. He is currently Acting Assistant Secretary for fossil energy.

[49] E-mail entitled "Fw: FutureGen release: FE first draft" from Victor Der to George Rudins, March 25, 2007.

[50] E-mail entitled "RE: FG @ Revised Congressional" from Thomas Shope to Dirk Bartlett, William Purvis and Raj Luhar, March 23, 2007.

[51] "DOE Signs FutureGen Cooperative Agreement," States News Services, April 10, 2007; "Rising Costs of FutureGen Plant Heighten Concerns among Legislators," *Platts Coal Outlook,* April 16, 2007.

[52] E-mail entitled "Re: FutureGen Agreement" from Michael Mudd to John Grasser, April 11, 2007.

[53] Transcript of Department of Energy conference call, Jan. 30, 2008. The speakers were Sell and Secretary Bodman.

[54] E-mail entitled "Re: Futuregen . . . problems" from Jeff Kupfer to Clay Sell, Sept. 9, 2007.

[55] E-mail from Thomas Shope to Clay Sell and Dennis Spurgeon, April 19, 2007; e-mail from Mary Egger to Gene Cadieux, April 16, 2007.

[56] "Meeting Notes 'To Discuss The Revised Cost Estimates For The Futuregen Project,'" attached to e-mail entitled "FutureGen Meeting Followup" from Thomas Shope to Jeffrey Kupfer, Dennis Spurgeon, Karen Harbert, Eric Nicoll and David Hill, May 11, 2007.

[57] E-mail entitled "Table of RTC Escalated Outlays," from Thomas Sarkus to Victor Der and Jeffrey Hoffman, April 2, 2007.

In an April presentation on the project's status to DOE, Mudd and his team pointedly noted that they "trusted" that DOE still shared the vision the administration had put forward "and planned to provide the political, technical and financial support required." He reminded DOE that the FutureGen Alliance was formed in "direct response" to President Bush's initiative, and that the industry was contributing nearly $400 million with "no expectation of financial return," but believed that FutureGen was central to reducing the cost of addressing climate change by "trillions of dollars." FutureGen was unique as no other fully integrated power plant combined gasification and carbon capture and sequestration in a deep geologic formation. It provided "a clear mechanism to assess the cost, performance, and public acceptance of integrated near-zero emissions power plant, which is an essential precursor to commercial deployment." Mudd also pointed to the global significance of such a project as a catalyst for new projects in other countries and its ability to position the U.S. as a leader on climate change solutions.[58]

Mudd reminded DOE that the Alliance members "came to the table" with certain understandings: the government would pay 74 percent of the cost; it would maintain its support of FutureGen; and that the $950 million cost was in FY 2004 dollars and subject to adjustment for inflation which would be shared. For their contribution, Alliance members would get no financial return or intellectual property rights. At that time, every milestone had been met. Construction would begin in 2009, but Mudd pointed out that heavy construction costs were up by 30 percent and well drilling costs by 250 percent.[59] Work continued through the summer on the design and the environmental impact statement, and DOE continued to solicit foreign partners.[60]

These exchanges marked the beginning of a dual track on FutureGen. The administration continued to unequivocally support FutureGen in public. For example, at the end of the April 2007 U.S.—EU summit on energy security, efficiency and climate change, the White House issued a joint statement pledging its support for FutureGen without reservation. "The United States, in partnership with its government steering group member countries and the private sector, will build FutureGen, the United States' first near-zero emissions fossil fuel plant, by 2012," the statement read. The first priority was deploying "near zero emissions coal technologies" which were critical in tackling global CO_2 emissions because of coal's importance in meeting energy needs.[61] FE pushed the general counsel's office to "move out on the EIS [Environmental Impact Statement]" so that final site selection could be completed by the end of 2007 because the states had purchase options on sites that expired at the end of the year.[62]

But inside the DOE leadership, it was a different story. In addition to meeting with White House staff, Deputy Secretary Sell was beginning to discuss the "path forward" with senior DOE officials, specifically on how to deal with the project's cost escalation. At the same time, the agency was preparing its FY 2009 budget. Funds for FutureGen—which did not have a specific line item in the budget—had to compete annually with other coal research projects such as the Clean Coal Power Initiative (CCPI) and regional carbon sequestration partnerships.

The Alliance did not want to negotiate a new cost agreement until it had completed more reliable cost estimates at the end of the first phase of the project in June 2008—as anticipated in the cooperative agreement—when it would have a more definitive design.[63] It responded to the pressure from DOE by appealing directly to President Bush in a letter on June 18, 2007. Describing FutureGen as a "premiere global project" with international partners, Mudd wrote that the Alliance members.

> have dedicated to FutureGen staff with global expertise in major design and construction projects, and the venture is operated with the clear objectives and management discipline of any major commercials endeavor. Costs are up for every major energy infrastructure project, but the FutureGen Alliance is watching costs closely as we share in the cost increases.

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[58] FutureGen Alliance, "FutureGen: Project Status," April 18, 2007, pp. 3–5 and 15.

[59] *Ibid.,* pp. 8, 10, and 14.

[60] See, e.g., e-mail entitled "FW: Revised TOC" from Joseph Giove to Carol Loman attaching IEA Ministerial 2007 Briefing Book Tasks, April 17, 2007.

[61] "2007 U.S.-EU Summit Statement: Energy Security, Efficiency, and Climate Change," The White House Press Office, April 30, 2007, pp. 1–2.

[62] E-mail entitled "Fw: FutureGen Meeting Followup" from Thomas Shope to David Hill, May 13, 2007.

[63] E-mail entitled "Re: FutureGen Mtg," from Victor Der to Raj Luhar, Mr. Giove, George Rudins and Jarad Daniels, May 7, 2007; e-mail entitled "FutureGen Path Forward," from Thomas Shope to Clay Sell, May 7, 2007.

Mudd reminded the President that "To date, your Administration has supported this important global effort" and referred to Bush's May 31, 2007, call for "expanding global cooperation on research and development to bring to market technology based solutions to climate change concerns." Continued government support of FutureGen was critical as staff had to be hired, land agreements made and major plant components with long manufacturing lead times needed to be ordered.[64]

DOE management was not deterred. By July of 2007, Shope had sent a memo to Secretary Bodman asking for the Secretary's approval of an immediate renegotiation of the final cost structure instead of waiting until June 2008.[65] The Alliance's initial response was that the cost increases were not the fault of anything the Alliance had done or failed to do, and reiterated the commitments the members had made through a non-profit consortium. According to the Alliance, there were already rumors from the foreign Alliance members that the U.S. might not be that committed to FutureGen. Nonetheless, Secretary Bodman approved Shope's proposal on July 27 without addressing the commitment issue.[66]

In an accompanying memo to Sell listing various options, however, Shope said that FutureGen was configured to "precisely" achieve the cost and performance goals for the zero emissions coal program and to gain industry acceptance and commercial deployment of the technology on a domestic and global scale. It also had strong international support as the "premier international, collaborative project" addressing greenhouse gases and climate change. Shope noted that the Alliance had been generally willing to work with the Department on cost overruns attributable to design errors, mismanagement, delays from accidents, etc. But the increases projected did not fall into any of those categories, and Shope was very skeptical that the industry would take on additional risk because there was no direct or immediate return on its investment, and it was risk-averse.[67]

Despite the recognition by DOE of these significant factors pointing to FutureGen as the only way to obtain the cooperation of the coal and power industry , DOE had already determined that it was not "financially sustainable." In an August memorandum to Bud Albright, DOE's undersecretary, Shope also said that the Administration was expressing concerns about the cost, although no documents have been provided to the Committee to verify that statement. However, it was clear that the Secretary's single goal was to limit the Federal Government's cost.[68]

DOE's plan to renegotiate was discussed with the Alliance staff, who told Sell they would work to resolve the issue before the final site selection at the end of the year, but whose nervousness about DOE's commitment to the project was evident. "The talk on the street that the project is in trouble is affecting [the Alliance's] ability to secure good vendors and competitive bids . . .. The Alliance has been told that some vendors are not interested in chasing after the FutureGen project if it just going to fall apart [sic]."[69] But in late August DOE told the Alliance board that a negotiation team needed to be formed.[70] According to talking points prepared for the meeting, Shope told the Alliance that "an 'open checkbook' approach is unsustainable and sets an unrealistic expectation which needs to be addressed. Simply put, we cannot commit to funding the project regardless of cost." For the Department to continue in the partnership, "the FutureGen financial plan must properly incentivize all parties to control costs and to account for those costs that are not directly controllable."[71]

It was a strange message to the partners that DOE had solicited to join in its risky project—and which everyone at DOE knew did not have much of an incentive to join. DOE was now threatening to pull out of its own project and appeared to be shifting the burden of the project momentum to the Alliance. It was now up to the Alliance to keep FutureGen alive.

In early September, staff at DOE's National Energy Technology Laboratory (NETL)—the managers of the FutureGen project—were told that "SE–1 [Secretary Samuel Bodman] and SE–2 [Deputy Secretary Sell] are directing DOE to 'renegotiate' the FG award, based upon their assessment that it is a 'bad deal.'" NETL was

[64] Letter to President Bush from Michael J. Mudd, June 18, 2007. No response to this letter was found in the DOE files provided to the Committee.

[65] "Memorandum for the Secretary" from Thomas D. Shope, July 27, 2007.

[66] "Memorandum for the Deputy Secretary" from Thomas D. Shope, Attachment A to "Memorandum for the Secretary, supra, July 27, 2007.

[67] *Ibid.*

[68] "Memorandum for the Deputy Secretary" from Thomas D. Shope, Aug. 31, 2007.

[69] Undated memo to Clay Sell. Because of the size of the components for an IGCC plant, the Alliance needed to order parts long before they were actually needed.

[70] "Appendix 2: DOE and FutureGen Alliance Communication Timeline," attached to undated FutureGen strategic plan.

[71] "Talking Points—Meeting with Futuregen Alliance Board of Directors," Aug. 29, 2007.

to identify areas for cost reduction.[72] In a preliminary meeting that Sell had with the Alliance, he was told that the Alliance was "potentially interested" in reducing its scope so that option was now on the table.[73] NETL quickly responded. "Anything but minor scope changes now could really screw things up." It could mean another site "best and final offer" process, a supplemental draft environment impact statement and perhaps the loss of some foreign contributors. NETL's counsel added, "I would be willing to bet the Alliance wants to reduce the CO_2 capture level and eliminate the co-sequestration test. The latter might not be such a big deal. The former could open a pandora's box."[74]

Sell also wrote to CEQ Chairman Connaughton, Barry Jackson, who had replaced Karl Rove, and Keith Hennessey, President Bush's chief economic adviser, at the White House, and Stephen McMillin, the Office of Management and Budget's (OMB) Deputy Director in charge of the federal budget, telling them that FutureGen was heading in a "bad direction." It was experiencing significant cost increases, and DOE might be forced to cancel. Sell said that neither the Secretary nor the OMB had contemplated these expenditures and expressed his belief that FutureGen was becoming a bad deal for the government and politically unsustainable in Congress. Sell said other priorities in coal research were being threatened by FutureGen.[75]

Connaughton, who was the Administration's representative at international meetings on climate change, asked that a "tiger team" be put together on the problem. Pointing out that FutureGen was an important part of the administration's climate change response, Connaughton emphasized, "This project is very important . . .. If there is a rational option, it should be considered."[76] There is no indication that this was done.

Options: Strip Down the Project or Change the Cost Share

As requested, FE had put together the pros and cons for various options. It did not favor any major change in the project scope because that would change the basic goals of the project, reduce international involvement and delay clean coal technology development. Specifically, it found scaling down the plant size from 275 MW to 120 MW, a 60 percent reduction which would reduce the cost by only 33 percent, would not meet industry's needs. It would be inefficient, delay the NEPA process, not meet the goal of sequestering one million tons of CO_2, and still require a subsequent demonstration in a larger plant. FutureGen's goals would be delayed by five years, and the total cost of the program would increase.[77]

Later in the negotiations, a NETL staffer worried: "It occurred to me that we are beating the process 'integration' drum pretty hard in our justification for FutureGen, but I don't think Jim Slutz and most of DOE top management (or anyone at OMB) have an intuitive feel for what these integration issues are and why dealing with them at large scale is so important . . .. The goal is to drive home the point that these integration issues are real and challenging, and are not going to be solved at smaller-scale."[78] Adding CCS to the back end of the system and making certain that all the pieces work in tandem would be a significant challenge.[79]

Another option was to break the project into three separate projects for 1) sequestration, 2) the turbine, and 3) the gasifier. FE described its previous negative experience with such a system and said it would be difficult to find companies to do the individual pieces because there was no economic reason to do so. For example, no one would take over the sequestration piece because there was no revenue resulting from sequestering, burying and monitoring CO_2.[80]

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[72] E-mail entitled "Fwd: Pre-Meeting Tuesday morning on FutureGen negotiations" from Keith Miles to Edward Simpson and Ferraro, Sept. 4, 2007. Miles asked the recipients not to "shoot the messenger" and said he was being "asked to identify a 'soldier' from your shop to participate."

[73] E-mail entitled "FG" from Adam Ingols to Thomas Shope and Andrew Patterson, Sept. 6, 2007.

[74] E-mail entitled "Re: Fw: FG" from Thomas Russial to Jarad Daniels, Victor Der and Thomas Sarkus, Sept. 7, 2007.

[75] E-mail entitled "Futuregen . . . problems" from Clay Sell to James Connaughton et al., Sept. 7, 2007.

[76] E-mail from James Connaughton to Clay Sell, Barry Jackson, Keith Hennessey and Stephen McMillin.

[77] DOE, *"FutureGen Options & Recommendations by DOE FE,"* October 2007, p. 4.

[78] E-mail entitled "Re: IGCC/CCS Process Integration Made Simple" from Jay Braitsch to Thomas Sarkus, Nov. 7, 2007.

[79] E-mail entitled "Re: IGCC/CCS Process Integration Made Simple" from Thomas Sarkus to Jay Braitsch, Nov. 7, 2007.

[80] *Ibid.,* pp. 5–6.

Reducing the research and development components of FutureGen, which had been sold as a “living laboratory” to test out new technologies was also rejected. The research was needed to prove that there would be no more than a 10 percent increase in the cost of electricity by adding CCS. Without testing in FutureGen, “advanced R&D components would first need to be proven independently and then proven in an integrated fashion at a commercially relevant scale” which “would significantly delay the availability of the technology for commercial deployment and would increase overall cost to the program.”[81]

FE also rejected reducing the carbon capture system efficiency from 90 to 50 percent, reducing fuel flexibility or removing the coal-to-hydrogen component. The only viable option for a successful FutureGen was to renegotiate the cost share and have a firm DOE cap as Secretary Bodman had made it clear that he would not sign on to a $3–$4 billion deal.[82]

In September of 2007, FE made its presentation to DOE Deputy Secretary Sell. Citing once again the benefits of FutureGen in proving advances in power generation in an integrated fashion with a variety of coal types, furthering international cooperation with coal giants China and India and proving the viability of widespread CCS, FE recommended that the project scope remain the same, but that further cost increases be shared 50/50 with the Alliance and title to the plant be given to the Alliance to be used for loan collateral.[83] DOE Under Secretary Albright, the agency’s lead on the negotiating team, apparently agreed with FE’s analysis.[84]

President Bush seemed unaware of the concerns of DOE management. He continued to tout the original program. On September 4, 2007, he issued a joint statement with then-prime minister John Howard of Australia welcoming Australia to the FutureGen International Partnership, which President Bush described as

> a major United States-led international project aimed at building a prototype plant that integrates coal gasification and carbon capture and storage to produce electricity with near-zero emissions. This demonstrates and underscores the commitment of both countries to the development and deployment of clean coal technologies.[85]

Negotiations

The initial negotiation session was held in the first week of October. In that meeting, the Alliance agreed to a 50/50 cost split after the first $1.8 billion, but said it had “cost flow constraints.” It was considering financing options to help “smooth” the costs to its members during the construction phase. The Alliance proposed that it receive 100 percent of the program income, and that DOE vest title to the plant in the Alliance at the beginning of the project, instead of the end. DOE found this unacceptable, but said internally that the next round of negotiations would focus on “ways to adjust revenue and cost share with the hope of finding a ‘win-win’ position.”[86]

The financing issue continued, however, to be the critical sticking point. The Alliance wanted to fund the project through a leveraging plan; DOE refused.[87] By the

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[81] *Ibid.,* p. 7.

[82] E-mail entitled “Fw: FG” from Victor Der to Thomas Russial, Thomas Sarkus and Keith Miles, Sept. 10, 2007; e-mail entitled “FutureGen” from Bradley Poston to Thomas Brown, Oct. 30, 2007.

[83] DOE, “FutureGen Renegotiation Issues and Recommendations,” Sept. 14, 2007. FE’s guidance for that meeting was to concentrate on scope reduction costs and benefits, not a change in cost sharing. E-mail entitled “FG Guidance” from Andrew Patterson to Jarad Daniels, Sept. 12, 2007.

[84] E-mail entitled “RE: FG Update & Data Call” from Jarad Daniels to Samuel Biondo, Victor Der and Joseph Giove, Sept. 21, 2007.

[85] “Statements about FutureGEN,” undated document from DOE, p. 1. President Bush also told foreign media in late May of 2007 that he believed FutureGen would be developed as a coal-fired plant with zero emissions. “And when that technology comes to fruition, if you can get yourself some coal, you’ve got your ability to diversify away from sole-source supplier of energy.” Remarks by President Bush in Roundtable Interview with Foreign Media, *http://fpc.state.gov/fpc/85918.htm*, May 31, 2007. International participation was not that easy to obtain. Prospective contributors weren’t sure what they were getting for their $10 million. Because of proprietary concerns, visiting researchers would not be able to fully view certain project areas. If too much information was shared, vendors might not be attracted to the project, DOE worried. Some kind of licensing arrangements might be possible, but they were never worked out. E-mail entitled “Re: FutureGen Renegotiation process update” from Thomas Russial to Jarad Daniels, Sept. 19, 2007.

[86] DOE, *“Brief Summary:* First Round of Negotiation between FutureGen Alliance & DOE,” Oct. 4, 2007, pp. 1–2.

[87] Attachment to e-mail entitled “FutureGen Timeline.doc” from Doug Schwartz to Kasdin Miller, Jan. 24, 2008.

end of October, DOE proposed that the individual Alliance members each give a guarantee "for a significant portion of the financing. If the Alliance defaults or withdraws, the members must pay over the guaranteed amount to the lender to reduce the outstanding debt thereby making it more economically practical for DOE to take over and complete the project." [88]

By early November, DOE told the White House that it had begun work on a "parallel strategy" if no agreement could be reached. It would seek to maintain the goals and objectives of FutureGen by "(a) adopting a different partnership construct that makes more sense for the Federal Government, or (b) separating the project's core technologies and accelerating our ongoing R&D efforts in these areas, testing at smaller scale with limited integration, and expediting deployment to the marketplace." [89] It was the beginning of what would be known as Plan B, an idea first mentioned by Bradley Poston in DOE's Office of Contract Management. Poston had asked if costs could be reduced by using an existing power plant to test out the carbon capture and sequestration products still in the research and development stage. Poston concluded that without carbon sequestration, there was no reason to proceed "so either the costs are reduced significantly or we revise our goals and focus on getting most of the technologies developed now so that in the future we can design and build with greater knowledge and confidence in our success and cost control." [90]

Plan B

Top DOE officials soon proposed a new FutureGen structure under which private companies would fund the IGCC plant, and DOE would pay only for the CCS component. In an e-mail exchange with a White House staffer, Albright described FutureGen's current structure as not only fostering cost overruns but actually threatening the "success of the underlying goals of FutureGen." [91] DOE's clean coal research team did not agree. According to FE, the national and global costs of not going forward with the original plan would be enormous. Private industry would not take on this challenge without significant incentives and the passage of carbon reduction legislation that gave a value to carbon. *"Given the above delays, and assuming a reluctance to pursue high-cost alternative pathways, it is reasonable to assume that without FutureGen, the availability of moderate-cost, coal fueled CCS plants would be delayed by 10–15 years."* (Emphasis in the original)[92]

The 10-year delay would result in a loss of U.S. emission reductions of about 22 billion tons of CO_2; a 15-year delay would result in a loss of 33 billion tons. For the rest of the world, however, the loss of this technological research would be *six times the U.S. losses,* or about 150 billion tons. Having a stream of commercially available, increasingly cost-effective coal/CCS technology options beginning in 2020 would also reduce electricity and natural gas costs. "Integration of concepts and components in a full scale test facility like FutureGen is the key to proving the technical and operational viability as well as gaining acceptance of the near-zero emission coal concept," staff wrote.[93] In undated notes of an internal discussion, Karen Harbert, the Assistant Secretary for policy and international affairs, also reminded the group that DOE had gotten a "plus up" in the FE budget by claiming that it would significantly accelerate CCS development by 2030, and that there would be a "*big* problem" if there was a delay.[94]

These warnings were pushed aside as Albright, Sell and the DOE policy staff moved forward with Plan B. This structure would scrap the cooperative agreement, the Alliance and the international partners for a new competitive procurement under which individual U.S. companies would take on the responsibility of building IGCC plants, and DOE would pay only the additional cost of the CCS component. At the same time, however, DOE continued to negotiate with the Alliance on the cost share and financial component and continued working on the EIS for the four

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[88] E-mail entitled "FutureGen Renegotiation" from Thomas Rusial to David Hill and Mary Egger, Oct. 19, 2007.

[89] E-mail entitled "New final paragraph for futuregen" from Adam Ingols to Sarah Magruder, Nov. 1, 2007.

[90] E-mail entitled "FutureGen" from Bradley Poston to Thomas Brown, Oct. 30, 2007.

[91] E-mail entitled "Re: FutureGen Funding" from Bud Albright to Charles Blahous and Clay Sell, Nov. 6, 2007.

[92] "Discussion of Alternative FE Clean Coal Program without FutureGen," p. 2, attached to an e-mail entitled "Re: Alternative FutureGen Plan C" from Thomas Sarkus to Doug Schwartz and Victor Der, Nov. 9, 2007. It appears that DOE briefly considering eliminating FutureGen altogether, but discarded that option.

[93] *Ibid.,* pp. 2–3. DOE, *"What 'Plan B' would NOT accomplish,"* undated.

[94] Undated notes of meeting on Plan B. Participants: Karen Harbert, Victor Der, Scott Klara and Jim Slutz.

sites which were the finalists.[95] FE raised again the problems with IGCC plants. Only two had been built, and both ran on natural gas, not synthetic gas or hydrogen from coal. "Some of us tekkies worry that hydrogen will pose an even greater challenge than syngas did. Add-in a water-gas shift reactor, which no IGCC plant now has. Then tack CCS onto the back end and make certain that all of the pieces work in tandem. You get the drift," a NETL engineer wrote.[96]

Other people started to raise questions, and the scramble was on to justify Plan B. A debate between Doug Schwartz, Albright's Chief of Staff, and Poston revealed the difficulties of making the new plan viable—even on paper. Poston said a new competition would delay the schedule, and he could see no industry self-interest. "We may give a party no one comes to," he wrote. Schwartz answered that DOE would just have to create more self-interest.

> [T]here may be a new model(s) we come up—in theory—that may alter our prior determination there is no return on investment for partners, whether resulting from changing the IP approach, permitting vendors to participate, an impending prospect of carbon regulation that did not exist so acutely in 2003, or other variables. In other words, there may be compelling reasons beyond corporate philanthropy for outside parties that would encourage their interest. Perhaps that is hopelessly naive on my part, but this is what we must fully explore and hopefully unlock.

Poston responded that he hadn't seen those compelling reasons. Although the potential return on investment was great in social terms, it was "non-existent in economic terms." Schwartz agreed with that conclusion, but argued that to come up with a viable Plan B, they needed to

> fundamentally alter our assumptions as we strive to come up with a new approach. So if we start the process with the goal of creating more self interest from the private sector (by granting more IP exclusivity, allowing vendors to compete, etc.), would that not change our thinking on how we might structure things? In other words, do veheicles [sic] like TIAs, loan guarantees, etc. become more viable tools if, at the outset, we seek to avoid a construct which is as "philanthropically" focused as the current deal seems to be?

Poston responded, "I am not certain how we can fundamentally alter the economics." He continued:

> The economics of our power production require other sources of revenue to offset the additional costs associated with carbon sequestration . . .. I have not heard of other revenue streams being identified except looking for participation from philanthropic organizations . . . but how would that play in the press? "DOE unable to support its own priorities; competes with the needy for funding?"

Schwartz admitted that "absent a basic change in some of the underlying assumptions, this is a circular exercise in which we will always arrive at the rightful conclusion that the current arrangement is the best mechanism for achieving our goals" (emphasis added).[97]

While this discussion was going on, Poston also wrote of his strong misgivings to Thomas Brown, the Director of the Office of Contract Management.

> Yesterday's meeting on what to do if an agreement on a revised Cooperative Agreement could not be reached included new participants but not new insights or conclusions.
>
> A very optimistic perspective was being offered on the possibilities of what we could do differently. I did try an [sic] add . . . an element of reality in that we

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[95] E-mail entitled "New final paragraph for futuregen" from Adam Ingols to Sarah Magruder, Nov. 1, 2007.

[96] E-mail entitled "Re: OGCC/CCS Process Integration Made Simple" from Thomas Sarkus to Jay Braitsch, Nov. 7, 2007.

[97] Series of e-mails entitled "RE: FutureGen Plan B" between Bradley Poston and Doug Schwartz, Nov. 6–9 and 15–19, 2007; undated memorandum entitled "Subject: FutureGen Option B" from Poston's files. Exactly what this change would be was unclear. In March of 2007, Thomas Shope testified before the House Energy and Commerce Committee that CCS technology would not be reliably available for commercial deployment until 2045 at the current level of funding for CCS and advanced power generation technology. George Rudins, then-Deputy Assistant Secretary for coal power systems, stated that the schedule could be accelerated by 20 years, but required annual federal funding of $1 billion plus deployment incentives. "It assumes a greatly expanded CCPI program and R and D. It also assumes a greatly expanded FutureGen program." E-mail entitled "Re: Date for CCS commercialization" from George Rudins to Frank Burke, March 7, 2007.

took our best approach with the initial award and that unless we have changed our program needs (which we have not), have reduced our cost drivers (which we have not), or can introduce new money (which we might be able to but on a such a small scale that it is immaterial) I could not see much choice except to step back and focus the Department's efforts on R&D . . ..

There are NO differences from 2003 so my response will sound like a broken record—if the current deal can not be satisfactorily restructured take our money and focus on R&D.[98]

But as Der told his staff: **"Doug [Schwartz] wants new ideas . . .. Doug is driving this with other hot shot project finance guys . . .. Have fun in this dump."**[99] (Emphasis added)

Operating on Dual Tracks

By the end of November, Sell was making daily requests for a detailed Plan B draft.[100] There is no indication that this option was ever shared with the Alliance until DOE made the announcement on December 18 that it was going to restructure FutureGen.

DOE's work on the Environmental Impact Statement required under the *National Environmental Policy Act* (NEPA) for the four finalist FutureGen sites was going forward as scheduled. DOE's October fact sheet on FutureGen mentioned that there were cost increases, but that they were "consistent with the increases seen in similar power plant projects and construction projects."[101] On October 30, a DOE employee said DOE was "diligently working" to complete the NEPA process and issue a Record of Decision (ROD) by the end of 2007.[102] The final EIS was issued on November 9.[103] On November 15, Albright and Slutz recommended that Secretary Bodman sign a letter to the Illinois Congressional delegation responding to an October 25 letter expressing concern about meeting the year-end deadline for a site selection. In that letter—which he later said was a mistake—Secretary Bodman repeated the commitment to complete the NEPA process and issue the ROD in a timeframe that supported FutureGen site selection by the end of December. Albright and Slutz also reminded the Secretary that the Texas legislature had passed incentives for a site in its state which would expire at the end of the year.[104] In late November, NETL staff was discussing a "big event" with DOE participation when the Alliance announced its final site selection.[105] By mid-December, sign-offs were being obtained on the ROD. The "potential" ROD signing was set for December 17 or 18, and a letter was drafted to the Alliance to that effect for Secretary Bodman.[106]

At the same time, the Alliance also was pushing forward. In early December, it issued Secretary Bodman an invitation to the site selection announcement on December 17.

But the negotiations were not going well. On December 6, the Alliance sent a letter to Albright stating that it wanted to proceed under the existing cooperative agreement until "costs and risks can be properly assessed with input from the upcoming preliminary design report and cost estimate." The Alliance members did not want to accept considerably more financial risk without this information which "both parties previously agreed would be a precursor to these discussions." The Alliance also accused DOE of taking away the legal and financial options that would help it manage risk even though they had been available under other cooperative agreements, but assured DOE that its members would honor their obligations. The

[98] E-mail entitled "FutureGen" from Bradley Poston to Thomas Brown, Nov. 7, 2007.
[99] E-mail entitled "This Coming Week" from Victor Der to Jarad Daniels, Nov. 9, 2007.
[100] E-mail entitled "RE: Fg" from Doug Schwartz to Andrew Patterson, Nov. 30, 2007.
[101] DOE, *"FutureGen, FC26–06NT42073,* October 2007, p. 3.
[102] E-mail entitled "Re: latest version" from Joseph Giove to Jarad Daniels, Oct. 30, 2007. A Record of Decision accepting the EIS must be signed by the agency before any federal funds can be expended.
[103] The final EIS was published in the *Federal Register* on Nov. 16. EIS No. 20070489, 72 *Fed. Reg.* 64619, Nov. 16, 2007.
[104] Letter from Michael Mudd to Secretary Bodman, Oct. 25, 2007; memorandum for the Secretary entitled "*ACTION;* RESPONSE TO LETTER FROM Illinois Congressional Delegation." At least two of the letters were signed, but not until Nov. 30. In a hearing before the Energy and Commerce Committee on Feb. 7, 2008, Secretary Bodman said it was a mistake. Letter dated Feb. 12, 2008, from Sen. Dick Durbin and Rep. Tim Johnson to Secretary Bodman.
[105] E-mail entitled "RE: SENSITIVE: FG Site Selection coordination????" from Thomas Sarkus to Victor Der, Carl Bauer and Miles Keith, Nov. 20, 2007.
[106] E-mail entitled "Cover Memo for FutureGen ROD," from Mark Matarrese to James Slutz, Victor Der, Jarad Daniels, Andrew Patterson, Kevin Graney, Raj Luhar, John Grasser and Robert Tuttle, Dec. 12, 2007; e-mail entitled "FG Draft Bodman Reply 11–15–07.doc" from Thomas Sarkus to Joseph Giove and Thomas Russial, Nov. 15, 2007.

Alliance said both parties should "convey positive messages about the project" and not suggest that the current agreement was "anything less than a 'good deal.'" Assuming release by DOE of the ROD by December 17, the Alliance would make the site announcement on December 18.[107]

In a detailed attachment, Alliance CEO Mudd laid out the basis upon which the Alliance was originally formed:

1. 20 percent cost-sharing;
2. no repayment requirement from industry partner;
3. ability to vest ownership of plant with industry partners;
4. potential for program income to be shared among project participants;
5. 100 percent of post-project revenues to industry partners; and
6. advanced appropriation of $300 million by DOE.

But the Alliance members had given up many benefits by forming as a 501(3)(c) non-profit corporation, which meant that no income or proceeds could go back to the original members, but must be reinvested in public benefit research and development. They got no intellectual property rights. The cost share increased to 26 percent. There was an agreement to negotiate limits to the federal investment subject to escalation after there was a more detailed site-specific design and cost estimate. Mudd also pointed to the offers made by the Alliance to share revenues and to share proceeds from the sale with DOE.[108]

Slutz responded in a short letter stating that DOE was evaluating its "next actions" with respect to the Alliance and the FutureGen project. He further said that the Alliance had scheduled its final site selection announcement without consulting with DOE—although DOE had been aware for months of the plan to make the announcement by the end of the year—and that DOE would consider it "inadvisable" for the Alliance to do so because DOE did not anticipate issuing the ROD.[109]

"Sanity Check"

In early December, Brad Poston was asked for a last "sanity check" on Plan B. In a meeting with Andrew Patterson, a senior policy adviser, Poston said that the most critical question was whether industry would want to participate and reminded Patterson that four years ago, industry had shown little interest in FutureGen. "[W]e would be asking a utility stereotyped as risk averse [sic] organization, to use our unproven design on their $2.5B investment."[110]

DOE top officials weren't having any of it. On December 7, Albright told Jeff Kupfer, Secretary Bodman's Chief of Staff, that further negotiations with the Alliance were "at best fruitless and likely counter-productive." Albright had a new overall plan, but needed the approval of Sell, the Secretary and the White House.[111]

On December 11, DOE briefed the National Economic Council deputies on the new plan. Secretary Bodman briefed the NEC "principals" on December 14 on DOE's intent to restructure.[112] The "new strategy" was laid out in a briefing memorandum. He would cap the government's financial exposure and pointed to developments, such as tax credits and loan guarantees for clean coal projects, that had occurred since FutureGen was conceived in 2003. DOE would issue a competitive solicitation "aimed at accelerating near-term commercial deployment of integrated IGCC commercial power plants with cutting-edge CCS technology." DOE would fund only the CCS component of multiple IGCC plants, which it estimated would cost $350–$500 million per plant. DOE's unnamed "experts" believed there would be "significant" private sector interest, although it had not discussed this with the private sector.[113]

Good Faith?

Whether DOE was operating in good faith during these negotiations with the Alliance is highly questionable. Secretary Bodman's intense dislike for the project was well-known by his staff. Undated notes recording a meeting about the legal obligations of the Department related to FutureGen read as follows: "S–1 [Bodman] aggravated by this project. Bob Card [former DOE Under Secretary] deal. Trying to do

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[107] Letter from Michael Mudd to Bud Albright, Dec. 6, 2007.
[108] *Ibid.*
[109] Letter from James Slutz to Michael Mudd, Dec. 11, 2007.
[110] E-mail entitled "RE: FutureGen" from Bradley Poston to Thomas Brown, Dec. 5, 2007.
[111] E-mail entitled "RE: FutureGen" from Bud Albright to Jeffrey Kupfer, Dec. 7, 2007.
[112] Attachment to e-mail entitled "FutureGen Timeline.doc: from Doug Schwartz to Kasdin Miller, Jan. 24, 2008.
[113] *Ibid.*

everything in one project get smart on alternative options. Can we turn this off/redirect?"[114] At the end of September, Albright told FE "to work under the assumption that a threshold at the 1.8B figure with a 50/50 split afterwards, with some adjustment for increasing Alliance membership, would be sufficient."[115] But on October 25, an FE employee walked into a meeting with several high-level DOE officials, including Albright, Alexander (Andy) Karsner, the Assistant Secretary for energy efficiency and renewable energy, and Karen Harbert, the Assistant Secretary for policy and international affairs.

> The topic of discussion seemed to be how best to kill FutureGen. It was great fun, with Karsner leading the charge by suggesting that we just compete FutureGen under the loan guarantee program and let industry fight over who gets the federal cost share, and touting how they make industry eat all the cost escalation in their biomass contracts.[116]

Interestingly, earlier in the year, Albright had been quoted as saying that any action on climate change had to involve the rest of the world. "Unless China and India are acting with us, it's pointless. They emit more carbon dioxide than we do."[117] Even though DOE and the Alliance had accomplished that goal and had both China and India as FutureGen partners, Albright was now in the lead to dismantle it.

Secretary Bodman appears to have made it clear to DOE staff that he did not care about the overarching goals of FutureGen, but only its cost. As Bradley Poston wrote in the midst of his efforts to contribute to a new plan, "I have an imperfect . . . understanding of the program; the current market conditions; and the changes in operating parameters from four years ago when the original acquisition strategy was developed. I see the true issue to be money and our ability to cap our financial exposure."[118]

Bodman's letter to Alliance CEO Mudd at the end of October stating that the ROD would be completed in time for a site announcement at the end of December appeared to be a commitment to the original FutureGen. But in December, Doug Schwartz, Albright's Chief of Staff, said everyone was "conveniently forgetting" one thing: "[W]e're here b/c S–1 [Bodman] wants to kill FG as its [sic] currently contemplated, with or without a Plan B."[119] It was also clear that everyone knew that Plan B had a very good chance of failing to meet the original goals. It would be cheaper, but it might not work, and carbon capture would then be delayed. "We discussed the additional risk to the company building the plant and if they would actually be willing to take on this risk. I don't think we will know that until we put out a RFI and see what industry says," Sarah Magruder Lyle, DOE's White House liaison, wrote. The "message" focus would be on fiscal responsibility. There would be no fully funded advance appropriations for Plan B. Research would continue under the Clean Coal R&D program as in the past.[120]

It is also clear that the Alliance did not know the details of Plan B during the negotiations, although Albright may have discussed it generally with some of the member companies.[121]

The Decision

White House staff was expressing "much angst" over what Plan B would mean for commercial deployment of CCS technology.[122] DOE officials asked for a clear deployment timeline of "educated guesses and assumptions." The response was lukewarm at best even from the policy shop.

> Schedule for plan B is commercial scale operation of two or three plants by 2015 with the demo lasting until 2018. *One could argue that you would have commercially deployed plants in 2015 and at a minimum you can argue that you would*

[114] Undated, handwritten notes from the Department of Energy. Author not identified.

[115] E-mail entitled "FG—update" from Jarad Daniels to Thomas Russial, Sept. 26, 2007.

[116] Untitled e-mail from Jarad Daniels to Victor Der, Oct. 25, 2007.

[117] Biography of C.H. Albright Jr., *The Almanac of the Unelected, 2007,* Bernan Press, Lanham, MD, p. 140.

[118] E-mail entitled "RE: FutureGen Plan B" from Bradley Poston to Doug Schwartz, Nov. 9, 2007.

[119] Untitled e-mail from Doug Schwartz to Julie Ruggiero, Dec. 10, 2007.

[120] E-mail entitled "Future Gen B Dec 12 2007 Final.doc" from Sarah Magruder to Karen Harbert, Dec. 12, 2007.

[121] E-mail entitled "RE: FutureGen Timeline.doc" from Mary Egger to David Hill, Jan. 24, 2009.

[122] E-mail entitled "timeline" from Jeffrey Kupfer to Bud Albright, Doug Schwartz and James Slutz, Dec. 13, 2007.

have them at 2018 assuming that **they are still doing CCS after the demo** (emphasis added).

On the other hand, FutureGen would operate from 2012–15. But if one "aggressively" assumed it would take three to five years before a commercial plant was built, you could claim the 2018–20 timeframe for the first commercial deployment—not exactly an acceleration from the original FutureGen.[123]

Nonetheless, the DOE higher ups had made their decision: Plan B would be rolled out with the promise that it would be better, faster and cheaper than the original FutureGen, regardless of the economics, industry interest, and the predictions of their own staff. Secretary Bodman communicated that to Senator Durbin in a phone call that apparently occurred on December 13.[124] On that same day, the NEC principals met and approved a restructuring of FutureGen if the Alliance didn't agree with all of DOE's demands.[125]

Victor Der, DOE's Deputy Assistant Secretary for clean coal, was blunt in his opposition. Plan B was only a demonstration which "will likely use more conservative, more costly and substantially less efficient IGCC–CCS technologies rather than the more aggressive technologies being developed in our R&D program aimed at potential cost and energy penalty reductions . . .. Under Plan B we would still have to follow up with sequential CCPI type demos which would incrementally add one or two advanced technologies at a time. This serial approach costs us time to fully deploy CCS globally." Der went on to say that his group's estimate that Plan B could delay by at least 10 years full commercial deployment of low-cost, low energy advanced CCS technology that could be transferred to developing countries wasn't included in the final analysis. A follow-up e-mail stated that affordable CCS technologies also would not be available in time for the expected turnover of the existing fleet of coal power plants in the U.S.[126] DOE officials responded by saying they were continuing to work "on a scenario that allows us to reduce/eliminate the 10 year deployment delay."[127]

Impact of OMB Budget Cuts

Secretary Bodman wasn't the only high-level government official not on board with the President's initiative. In September, DOE's budget shop told FE that the President's budget had additional funding that enabled FutureGen to stay on track and supported the baseline schedule. It reflected the ramp-up of activities as the program moved toward full-scale operation in 2012. FY 2009 activities included the complete detailed design of a prototype plant, money to initiate construction and the continued procurement of long-lead equipment.[128] But in November, the Office of Management and Budget (OMB), which was well aware of Bodman's opposition, eliminated all of the climate change funds from FE's budget.[129]

In early December, James Connaughton, the Chairmanaman of the President's Council on Environmental Quality (CEQ), met with representatives from Fossil Energy to discuss clean coal research in preparation for his attendance at the United Nations Framework Convention on Climate Change in Bali. Connaughton—who may not have been fully aware of the unrelenting drive toward Plan B—said that the U.S. had two options: either invest billions of dollars to develop the technologies to address climate change; or face a new regulatory environment that would not advance the technology. He also said that the U.S. needed to elicit more parallel activity in China and India.[130]

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[123] E-mail entitled "timeline" from Jeffrey Kupfer to Bud Albright, Doug Schwartz and Jim Slutz, Dec. 13, 2007; e-mail entitled "RE: timeline" from Andrew Patterson to Mr. Schwartz and Mr. Slutz, Dec. 13, 2007.

[124] "Meeting Memorandum" to Secretary Bodman from Lisa Epifani regarding phone call to Senator Richard Durbin scheduled for December 13, 2007. Other reports put the call on December 14 and we know that it was postponed at least once from December 12. However, the call did occur.

[125] Attachment entitled "Purpose of Meeting" to e-mail entitled "FG principals mtg statement.doc: from Mary Egger to Mary Egger, Jan. 24, 2008.

[126] E-mail entitled "Re: timeline" from Vic Der to Mr. Slutz, Carl Bauer and Scott Klara, Dec. 13, 2007; "What 'Plan B' would NOT accomplish," attachment to e-mail entitled "FW" FG Plan B" from Jarad Daniels to James Slutz, Dec. 13, 2007.

[127] E-mail entitled "FW: FutureGen/CCPI funding (With brackets) from Darren Mollot to Jay Hoffman, Dec, 17, 2007.

[128] E-mail entitled "Proposed Change for FutureGen" from Karen Brown to Patty Graham, Robert Pafe, Jarad Daniels and Jordan Kislear, Sept. 28, 2007.

[129] E-mail entitled "Re" FY 2009 Budget intelligence" from Jeffrey Kupfer to Steve Isakowitz and Clay Sell, Nov. 15, 2007.

[130] E-mail entitled "Recap of CEQ meeting on FY09 Passback" from Jarad Daniels to Victor Der, Nov. 30, 2007. CEQ did host a meeting on FutureGen in early October to which representa-

Connaughton's concerns were to no avail. On December 11, while he was in Bali, he received an e-mail from Karen Harbert at DOE. "I know how busy you are in Bali, but without significant interest by WH offices, we will not have a serious effort in climate," she wrote—and there was no such interest. Harbert went on to says that in the FY08 budget request, DOE had shifted over $500 million toward high-priority programs, including Futuregen, in clean coal and nuclear research and development, but OMB had eliminated all of the additions. Harbert acknowledged that the heavy emphasis on CCS would also help reduce emissions in China and India, but that OMB had eliminated "all funded increase for clean coal, greatly undermining plans for critical demonstrations as well as FutureGen." [131] In a related e-mail, Connaughton was portrayed as being

> very apprehensive about the international piece—and how we deal. What happens to other countries, etc. Bottom line is that he likes his international talking point and wants to keep it. CEQ is going to try to set up a call for you [Harbert] and him sometime later today—so that you can convince him that this is meangeale [sic]. Hopefully you can do that.[132]

These budget cuts made it extremely difficult, if not impossible, to build the original FutureGen under any circumstances, as the DOE expenditures were front-loaded in the project schedule, even with a 50/50 cost share after the initial $1.8 billion was spent.

Announcement by Alliance of Final Site Selection

The Alliance's time line established the end of 2007 for the announcement of the final site decision. As DOE had completed the final EIS, the Alliance scheduled the announcement for December 18. The winner was the State of Illinois with a site near the city of Mattoon. But within hours, DOE, in a statement made by James Slutz, said that "the public interest mandates that FutureGen deliver the greatest possible technological benefits in the most cost-efficient manner. This will require restructuring FutureGen to maximize the role of private sector innovation, facilitate the most productive public-private partnership, and prevent further cost escalation." [133] DOE also stated that it would not sign the Record of Decision on the EIS which was required before any federal project construction funds could be expended.[134]

Plan B Goes Forward

During January, there were some continued negotiations with the Alliance as the White House had not yet officially signed off on Plan B. On January 10, the Alliance sent a letter proposing a "new approach to financing FutureGen." It would increase its cost share if overall costs went up, make post-project repayments and do partial bank construction financing. Under this approach, the Alliance claimed the final taxpayer investment would be no greater than it was on the day President Bush announced the project.[135] But DOE internally remained focused on Plan B. Albright told DOE and White House staff that "[r]egardless of the value of their proposal, we need to continue to move expeditiously with the new direction rollout." The Alliance, for its part, refused to share the details of its proposal unless there was an "in person" meeting.[136] DOE's clean coal staff had one job left: make the fantasy that was Plan B look good on paper.

Putting together a seemingly logical story around Plan B to sell to the White House, Congress, the press and the public was not an easy job. After reviewing a rough outline of the program plan, Victor Der forwarded it to Jay Hoffman, DOE's Director of program analysis and evaluation with this message: "Here's the Frankenstein. I'll be calling NETL to see where they are in the electrodes development

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tives from the White House, the Office of Science and Technology Policy and DOE were invited. E-mail entitled "CES mtg. re. FutureGen" from Doug Schwartz to Nell Kinsey, Oct. 2, 2007.

[131] E-mail from Karen Harbert to John Herrmann, NSC, Dec. 11, 2007, enclosing e-mail entitled "DOE Appeal Status" from Ms. Harbert to James Connaughton, Dec. 11, 2007. Harbert said DOE had appealed $380 million but recovered only $24 million.

[132] E-mail from Jeff Kupfer to Karen Harbert, undated.

[133] "Statement from U.S. Department of Energy Acting Principal Deputy Assistant Secretary for Fossil Energy," Dec. 18, 2007.

[134] AP, "Mattoon, Ill. picked for FutureGen pollution-free coal plant," Dec. 18, 2007; e-mail entitled "Backlash draft" from Julie Ruggiero to Megan Barnett, Dec. 18, 2007.

[135] Letter dated Jan. 10, 2008, from Michael Mudd to C.H. Albright, p. 1.

[136] E-mail entitled "RE: FutureGen" from Bud Albright to Cynthia Bergman, Charles Blahous, Jeffrey Kupfer, Andrew Beck and Lisa Epifani, Jan 16, 2008.

to make it walk." [137] Hoffman responded with a new "FutureGen Plan B Storyline." The main rationale, according to Hoffman, was "a more appropriate public/private cost allocation between DOE and industry. *Secondary benefits may include accelerated commercial demonstration and more carbon-free power, but these are not driving reasons for why Plan B is being developed"* (emphasis added), Hoffman wrote. IGCC technology was "a largely commercially proven technology" and didn't need government assistance. CCS, on the other hand, was "largely unproven," and DOE would pay for the resulting research and development, operating and maintenance and parasitic energy losses that the private company would incur.[138]

After looking at the "story line," Der wasn't convinced. "[T]he FrankenGen document, I mean, New FutureGen, needs to be taught to walk first, before it can hop on a Harley." [139]

A few days later, Secretary Bodman was briefed by Albright on DOE's "new focus." The possible "secondary benefits" became real benefits in this presentation. Because of construction costs, "growing near-term interest in carbon dioxide regulations and states beginning to require CCS or the flexibility to add CCS for siting/permitting of coal plants," DOE was now going to focus on "first-of-a kind full utility-scale demonstrations and developing data on commercial cost, integrated IGCC–CCS performance and reliability to reduce risk, confirm economics and facilitate industry-wide private capital offerings." This would allow for early deployment of "nearer-term IGCC–CCS technologies" at commercial plants and would also address the "very critical technical feasibility question" of a near-zero emission coal plant. There would be a minimum of two 600 MW plants, each of which would capture and store at least one million metric tons of CO_2 per year. Staff did note, however, that cost reductions and competitive technology were still needed for full deployment, and that those technologies would still have to be demonstrated later. There was no explanation about why industry would test technology that was not yet cost-effective.[140]

The Department also struggled to put together an internal "strategic plan" for the White House that would incorporate—with some facial credibility—the new FutureGen structure while claiming to maintain the original goals of an IGCC, near-zero emission plant. DOE postulated that because of the challenges of getting coal-fired plants licensed, this "change in the market landscape" had "catalyzed the need" to demonstrate the commercial viability of an IGCC/CCS plant. However, because of the uncertainty about the cost and performance of such plants, plans for them were being abandoned or postponed. "Unless the production of electricity from coal integrated with sequestering carbon dioxide can be shown to be commercially feasible and cost competitive, the coal industry will not make the investments necessary to fully realize the potential energy security and economic benefits of this plentiful, domestic energy." [141] Reducing that uncertainty of course, was exactly what the original FutureGen was supposed to demonstrate. But in an inexplicable shift in reasoning, DOE then said that it would achieve its goals more quickly if it could attach a CCS technology to a commercially built IGCC plant. It would speed up commercialization, help drive the regulatory framework and address the "very critical technical feasibility question of advanced technology clean coal plants." [142]

FE did not go down without a fight. On January 10, Jay Hoffman, Director of the Office of Program Analysis and Evaluation, who was working on the FY 2009 budget, laid down the law to Victor Der and Jarad Daniels.

> Let me get right to the point. As written, the CFO's [Chief Financial Officer] office will not concur on the project plan. It is sorely lacking in detail and analysis, and provides little defense or answer to the difficult questions we will field from the WH, the alliance, and ultimately the public/Congress . . .. My expectation was for your office to develop a solid, analytically supported plan that at a minimum included the suggested analysis, with the caveat that you could determine how best to frame the story around that analysis.

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[137] E-mail entitled "Plan B Program Plan 12_20_2007.doc" from Victor Der to Jay Hoffman, Jan. 2, 2008.

[138] E-mail entitled "FY09 FutureGen Program Plan Storyline" from Jay Hoffman to Victor Der, Jan. 4, 2008.

[139] E-mail entitled "FW: A Program Plan for Demonstration of Integrated Electric Power Production and Carbon Sequestration" from Victor Der to Jay Hoffman, Jan. 2, 2008; e-mail entitled "RE: FY09 FutureGen Program Plan Storyline" from Victor Der to Jay Hoffman, Jan. 4, 2008.

[140] "New FutureGen: Briefing to Secretary of Energy." Jan. 9, 2008, pp. 2–3.

[141] "Draft Strategic Planning Document for Revised FutureGen: Demonstration of Integrated Electric Power Production and Carbon Capture and Sequestration," December 2007, p. 4.

[142] *Ibid.,* p. 2.

Hoffman said he expected a revised project plan for the decision makers that would be "bullet proof and ready for the WH." It needed to describe what went wrong with the original FutureGen and why Plan B would be successful, including why industry would buy into it.[143]

The goals listed in the new FutureGen in the final drafts read like DOE's ultimate coal dream: it would validate CCS at multiple sites, it would inject and monitor CO_2 at multiple geologic formations, integrate CCS with multiple gasification-based power production technologies; develop a regulatory and permitting system; provide the possibility of international participation at more than one project; produce a more comprehensive and reliable set of operating data, and promote early widespread deployment of IGCC–CCS technology. In addition, it would capture at least 90 percent of CO_2 and mercury, 99 percent of sulfur, and reduce NO_X and particulate emissions. And all this came with a lower federal price tag.[144]

There, of course, was one big problem: Plan B would cost the power generator a great deal of money in capital, operating and maintenance and parasitic energy loss costs. DOE's program and budget people struggled for a month to put together a cost estimate that would be lower than the original FutureGen. Initially, DOE was going to pay for the parasitic energy loss, but that became too expensive so it was deleted. The government would only pay capital costs for the CCS addition to an IGCC plant. Questions raised about the readiness and costs of the CCS technology were ignored. "Biggest area of concern remain 'new technology' and the insertion of this new technology into a 'generic' plant; not sure of the true impact and cost implications," the Director of the Office of Engineering and Construction Management wrote.[145] "Taking these concerns in totality, and looking at it from industry's perspective, how does this uncertainty impact the profit potential of the project? At the end of the day, this will determine participation by industry," other DOE officials warned.[146]

There was another concern: the White House hadn't yet signed off on DOE's plan.[147] The final White House meeting was on January 25. DOE presented a strategic plan, complete with proposed press release and request for information (RFI), for Plan B to go out on January 31. DOE would contact the Alliance and make a final offer: the Alliance had until January 29 to accept the terms, which had a "50/50 cost share after the 1.8, and stating that the Alliance contribution may not include project financed debt." If the Alliance did not accept those terms, DOE would announce its new approach and put out the RFI on Jan 31.[148]

The White House meeting was to be hosted by Keith Hennessey, NEC's Director and economic adviser to President Bush. Invited participants included OMB Director Jim Nussle; David Addington, Vice President Cheney's counsel; Press Secretary Dana Perino; Joel Kaplan, White House Deputy Chief of Staff; CEQ Chairman Connaughton; Presidential Counselor Ed Gillespie; Charles Blahous, NEC Deputy Director; and Dr. John Marburger, Director of the Office of Science and Technology Policy.[149] Sell and Albright were to "tell WH details of going forward and get blessing."[150]

Albright and Sell told the NEC principals everything they needed to hear to believe that the Bush initiative would remain intact. The restructured FutureGen would achieve all of the primary technical goals of the original project which was "no longer optimal to achieve the goal of accelerating the commercial demonstration

143 E-mail entitled "FW: FY09 FutureGen Program Plan Storyline" from Jay Hoffman to Victor Der and Jarad Daniels, Jan. 10, 2008.

144 "Draft Strategic Planning Document, December 2007, *supra,* pp. 3–4.

145 E-mail entitled "RE: Cost estimates for FutureGen Plan B" from Paul Bosco to Jay Hoffman and Melvin Frank, Dec. 19, 2007.

146 Attachment to e-mail entitled "plan b observations.doc" from Jay Hoffman to Andrew Patterson and James Slutz, Dec. 13, 2007. Also, the Director of DOE's Office of NEPA Policy and Compliance didn't think that DOE had a credible NEPA strategy for Plan B since only one of two units at a site would capture 90 percent of the CO_2, and there were other pollutants. FutureGen was a "major source" under the *Clean Air Act,* she reminded the general counsel's office. E-mail entitled "re:: fg DOCUMENTS" FROM Carol Borgstrom to Mary Egger, Jan. 16, 2008.

147 E-mail entitled "draft talking points for S–2 tomorrow with Texas Railroad Commission" from Jarad Daniels to Kevin Graney, Jan. 17, 2008; e-mail entitled "Re: FutureGen—Ltr to Alliance (jan 18).doc" from Adam Ingols to Doug Schwartz, Mary Egger, James Slutz and Eric Nicoll, Jan. 18, 2008.

148 E-mail entitled "Re: FutureGen issues and actions" from Scott Klara to Jarad Daniels, Jan. 24, 2008.

149 E-mail entitled "1/24 FutureGen Principals Meeting—TIME CHANGE" from Kristin Marshall to Ann Merchant et al., Jan. 23, 2008.

150 E-mail entitled "Re: FutureGen issues and action" from Scott Klara to Jarad Daniels, Jan. 24, 2008.

and deployment of advanced, integrated coal-based power systems including CCS." But the government's financial exposure would be limited to mitigating the "incremental risk of the addition of CCS" while its investment would be leveraged "across a wider range of nearer-term coal based IGCC–CCS projects." [151] Not only would it accelerate deployment of CCS technology, restructured FutureGen would establish the technical feasibility and economic viability of producing electricity and hydrogen from coal with near-zero emissions. It would verify the sustained, integrated operation and effectiveness, safety and permanence of a coal conversion system with carbon sequestration, it would establish standardized technologies and protocols for CO_2 monitoring, mitigation and verification, it would sequester at least one million tons of CO_2 in saline formations; it would capture at least 90 percent of the CO_2 emitted; 90 percent of the mercury emitted; 99 percent of the sulfur and high levels of NO_X and particulate emissions. There would be a more rapid investment by industry in multiple demonstrations of "near-commercially available technologies" for CCS.[152]

Additionally, because of the loss of the "living laboratory" element of FutureGen, there would be a "fresh look at the commercialization profile of key FE technologies." This was a particularly puzzling statement because the table of technologies that followed made it clear that most of them were still at the bench or laboratory stage of development, and FE would have to find alternative host sites. There were other confusing statements. While admitting that Plan B would delay the cost-reduction improvements that were ultimately needed for coal/CCS plants to be an attractive commercial option in both the U.S. and internationally,[153] Sell and Albright claimed that it would demonstrate "commercial feasibility." Private companies apparently were now expected to quantify the technical and economic risk associated with near-zero emissions coal plants, thus "enabling private financing decisions of future plants of this type" and facilitating "industry-wide private capital offerings." [154]

But deep in the strategic plan was the recognition that incorporating CCS on a commercial-scale IGCC plant added capital and operating costs and "is still perceived by the electricity generation industry as an emerging technology. Concerns remain over the integration and scale-up risks associated with IGCC, and a cost gap still remains when compared to conventional coal power plants." Industry's reaction to the new program would depend on the "magnitude of the government's commitment to the project" and its ability to "reasonably satisfy" those concerns and allow the plants to function competitively. And, of course, there was that troubling issue of liability for the sequestration of CO_2.[155]

DOE also claimed that its international partners would favorably respond, even though they no longer could share in the technology development or work at the new sites. Inexplicably, DOE found that the new approach would actually "raise the efficiency of information sharing." [156]

Albright and Sell were successful. By January 28, everyone in the White House was "on board" with the announcement for a restructured FutureGen.[157]

In the final strategic plan, DOE ignored every concern of its own staff. "Today, more than ever, the concept of FutureGen is a centerpiece for the future of coal utilization," the plan trumpeted.

FutureGen directly addresses a primary goal of the Department of Energy's (DOE) 2006 Strategic Plan under the Theme for Energy Security to promote America's energy security through reliable, clean, and affordable energy: Environmental Impact of Energy: "Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water and air from energy production and use."[158]

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[151] "Draft Strategic Planning Document for Revised FutureGen: Demonstration of Integrated Electric Power Production and Carbon Capture and Sequestration," Jan. 30, 2008, pp. 2–3 and 8.

[152] *Ibid.,* p. 3.

[153] "Under Revised FutureGen commercial deployment of cost-reduction improvements could be delayed unless other test approaches are found, such as designing limited test capability . . . into Revised FutureGen and CCPI demonstrations." *Ibid.,* p. 7.

[154] *Ibid.,* pp. 3 and 7–8.

[155] *Ibid.,* pp. 16–17.

[156] *Ibid.,* p. 17.

[157] E-mail entitled "FutureGen" from Cynthia Bergman to Megan Barnett, Jan. 28, 2008.

[158] DOE, *"Draft Strategic Planning Document for Revised FutureGen: Demonstration of Integrated Electric Power Production and Carbon Capture and Sequestration,"* Jan. 31, 2008.

January 30, 2008 announcement

Secretary Bodman met with the Illinois delegation on January 29 to forewarn them of the announcement. His plan was very poorly received by both Republicans and Democrats, who called it "unfair," "cruel" and "incompetent management." They asked how DOE could throw away Illinois' five years of work.[159] Just before the announcement, Illinois Republican Congressmen Tim Johnson and John Shimkus made an appeal directly to President Bush to save the project. The President said he stood by Bodman's decision.[160]

DOE then announced that it would "join industry" in its efforts to build IGCC plants by providing funding for the addition of CCS technology to multiple plants that would be operational by 2015. According to DOE, this would double the amount of CO_2 sequestered compared to the original FutureGen.[161] The restructured approach allowed DOE to "maximize the role of private sector innovation, provide a ceiling on federal contributions, and accelerate the Administration's goal of increasing the use of clean energy technology to help meet the steadily growing demand for energy while also mitigating greenhouse gas emissions."[162] Secretary Bodman also claimed that engagement with the international community would remain "an integral part" of DOE's efforts, although he had already been told that private companies would not be interested in freely sharing their technology with other parties, foreign or domestic.[163]

The mysterious "technology advance" that Secretary Bodman and others kept referring to was that, unlike in 2003, there were now over 33 IGCC plants that have been proposed, even though a number of them had already been cancelled. In a follow-up conference call with reporters, Sell claimed that "[t]his fact, this changing underlying market dynamic, underpins why we believe our new approach is fundamentally better to advance the state of carbon capture and sequestration." He expressed his confidence that restructured FutureGen was a better way to go. "We are making this project better and we are increasing substantially the likelihood of success."[164] Sell even claimed that the National Energy and Technology Lab's (NETL) work gave him that confidence, despite the fact that NETL, FE and others had been protesting for months that the new approach would not work.[165]

There was no discussion of who would take on the liability for sequestration or who was going to pay for the energy loss associated with CCS or how the technology had suddenly advanced to viable commercialization. DOE would issue a Request for Information to the industry to determine its views (which had not been sought before the announcement). It would be followed by a competitive Funding Opportunity Announcement.[166] Any loss of the research and development aspects of FutureGen would be made up in a significant increase in the FY 2009 clean coal budget.[167]

The RFI asked for input and public comment on the restructured FutureGen and expressions of interest from power producers who would consider participating in the revised initiative. These responses would help shape a competitive funding opportunity announcement expected to be released in June of 2008. DOE stated it was interested in funding multiple demonstrations of CCS technology at a commercial scale of at least 300 gross MW per unit plant power train per demonstration. It would contribute no more than the incremental cost of the CCS for one train. At least 1 million metric tons of CO_2 would be stored in a saline storage formation, and all emissions levels for other pollutants would meet the original FutureGen goals. Commercial operations were expected to begin in 2015.[168]

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[159] E-mail entitled "re: FG REDLIGHT—S–1 agreed to wait one day" from Jeffrey Kupfer to Eric Nicoll et al., Jan. 29, 2008.

[160] "Durbin sees 'uphill struggle' to save FutureGen; Energy Dept. confirms it is pulling its back for the coal-fueled experimental power plant in Mattoon, Ill.," St. Louis Post-Dispatch, Jan. 31, 2008, D2.

[161] FE staff had told the policy and press staff that if they were going to maintain the 90 percent carbon capture goal, IGCC was the only credible approach. E-mail entitled "RE: FOR YOUR REVIEW—updated fact sheet and press release" from Jarad Daniels to Megan Barnett, Jan. 22, 2008.

[162] "DOE Announces Restructured FutureGen Approach to Demonstrate CCS Technology at Multiple Clean Coal Plants," press release, Jan. 30, 2008.

[163] *Ibid.*

[164] Transcript of Department of Energy conference call," Jan. 30, 2008. The speakers were Clay Sell and Secretary Bodman.

[165] *Ibid.*

[166] DOE press release, "DOE Announces Restructure FutureGen Aproach to Demonstrate CCS Technology at Multiple Clean Coal Plants," Jan. 30, 2008.

[167] "FutureGen Talking Points," undated.

[168] DOE, *"Request for Information (RFI) on the Department of Energy's Plan to Restructure FutureGen,"* Jan. 31, 2008.

Response to Restructured FutureGen and Request for Information

The response was quick and skeptical with most of the media viewing FutureGen as dead. "The Administration has long trumpeted technology, not regulation, as the answer [to global warming]. There was no trumpeting last week when it unexpectedly canceled FutureGen—its much-touted, $1.8 billion attempt to develop a cutting edge coal plant that would turn coal to gas, strip out and store underground the carbon dioxide that contributes to climate change, and then burn the remaining gas to produce hydrogen and electricity," *The New York Times* wrote. "And what of Mr. Bush's hydrogen-powered Freedom Car? That, too, has receded from view." The newspaper described the decision as ending a four-year-old program that had been described as "one of the boldest steps our nation has taken toward a pollution-free energy future."[169] The *St. Louis Post-Dispatch* opined that Secretary Bodman apparently missed the part of Bush's 2008 State of the Union address on the previous day where the President urged Congress to "fund new technologies that can generate coal power while capturing carbon emissions." *IEEE Spectrum* described the decision as bringing FutureGen to a "screeching end."[170]

The responses received in March from industry to the Request for Information were more damning. There were 49 responses, almost all of which took major "exceptions to the RFI specifications and near zero emissions objectives," a DOE summary document reported. Industry wanted the solicitation expanded to non-IGCC technology; a "substantial relaxation" of the 90 percent carbon capture requirement; government liability protection of the CCS aspects of the projects; elimination of the mandate to sequester one million tons of CO_2 in a saline aquifer and permission to sell CO_2 for enhanced oil recovery; guaranteed funding up front; an expedited NEPA process; a sharing of the additional operating and parasitic energy costs; and reductions in the performance targets of sulfur, nitrogen oxide, particulate matter and mercury. The comments also suggested that the schedule was unrealistic.[171]

The comments from the Coal Utilization Research Council (CURC), an industry advocacy group that focuses on the technology development steps necessary to achieve near zero emissions from coal power generation (and which opposed the termination of FutureGen), were particularly negative. There wasn't enough money for "multiple" CCS projects (CURC estimated at least $600 million needed for each project), nor was there any assurance that Congress would provide funding; 90 percent CO_2 capture was not realistic for a commercial project; and non-IGCC projects should be considered.

> Given the immature state of experience in using capture technology integrated with an IGCC, for example, CURC believes it is much more prudent to simply encourage the installation of CCS technology on a unit that will be commercially-operated rather than dictate the level of capture. Industry should be free to determine what level of capture of CO_2 makes the greatest sense from both a cost and acceptable risk exposure perspective.

CURC also estimated that installing CCS systems on to commercial projects would cost hundreds of millions, if not billions, of dollars, and the owners "should not be restricted to the 90 percent capture requirement that is otherwise germane to a technology demonstration project (i.e., FutureGen)." Additionally, a much larger initiative was necessary to continue a large-scale, industry-supported CCS implementation partnership.[172]

These were the same points DOE staff had raised earlier. In an issues document based on the comments, DOE staff wrote: "In the current environment, utilities planning new base load power capacity have compelling incentives to adopt a 'wait and see' approach while issues related to retail competition and carbon management are resolved. Moving forward with CCS at this time, absent legislation or other incentives, would be imprudent." Industry also was expressing skepticism about government support for the new program because of the change in direction and the change in administrations.[173]

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[169] "Higher Costs Cited as U.S. Shuts Down Coal Project," *The New York Times,* Jan. 31, 2008, C5; "Late and Lame on Warming," *The New York Times,* editorial, Feb. 4, 2008.

[170] "Back to the FutureGen," *St. Louis Post-Dispatch,* Jan. 31, 2008, C8; "U.S. Government Terminates Its Major Clean Coal Project," *IEEE Spectrum OnLine*, *http://blogs.spectrum.ieee.org/tech—talk/2008/02/us_govt_terminates_its_m.html*

[171] DOE, *"Expanded Summary of Comments Received Under DOE's Request for Information (RFI) on Plan to Restructure FutureGen,"* March 20, 2008.

[172] "Comments Submitted to the Department of Energy by the Coal Utilization Research Council (CURC) in Response to a Request for Information (RFI) Issued by the DOE," March 3, 2008, pp. 1–3 and 4.

[173] DOE, *"Revised FutureGen Project—Outstanding Legal, Contractual and Policy Issues,"* March 25, 2008, Rev. 1, p. 1. DOE also expressed the fear that if the CCS technology failed,

DOE plowed forward, reiterating once again to Illinois Congressional members that its approach would help permit new commercial coal plants.[174] However, it hid the supposedly "public" comments from the public and the press by refusing all requests to release them.[175]

But there were other public forums which clearly exposed the problem DOE was going to have in getting responsive proposals. In May of 2008, the greenhouse gas research and development program and the clean coal center of the International Energy Agency held a workshop on financing CCS. The workshop participants' view was that private investment in CCS in North America was an "unattractive financial option without Government incentives and a legal framework in place." As a representative of JP Morgan Chase said, CCS has no positive purpose. It only has a negative purpose to avoid the cost of putting CO_2 into the atmosphere, and that has no cost in the United States. The investment banks wanted a "secure return on their investment, such as loan guarantees or tax credits." Legal and environmental liability was an issue, and insurance companies were not ready to take on this risk. Until there was greater regulatory and cost recovery certainty, the private sector would not invest. And, "ultimately, the willingness of ratepayers to pay higher electricity bills to pay for CCS, as reflected in decisions by local public utilities, will be critical to the financing of such projects," the participants agreed. "It is clear that CCS is not economic and subsidies will be needed for the first plants . . .. [F]inancing is the key and ultimately without financing there will be no CCS deployment."[176]

Funding Opportunity Announcement (FOA)

The Draft Funding Opportunity Announcement was issued on May 7, 2008. Despite the RFI comments, it remained focused on a gasifier technology. As CURC stated in its comments, the FOA described a commercial-scale project which included the goals and objectives of the original FutureGen, which was a publicly cofunded demonstration-scale project, and that was not viable.

> Included among our suggested modifications are changes to FOA requirements related to emission controls of criteria pollutants, beyond that which is required for permitting plants today, a level of CO_2 capture percentage that has not been previously achieved in power plants at a commercial scale, dates for operation that may be difficult to achieve and other criteria that also may not be realistic or prudent when measured against the business requirements of a facility, or facilities, planned and constructed to operate successfully in commerce.

CURC reminded DOE of its earlier comment that there was not enough money for multiple projects, and, since future funding was not guaranteed, "there are not clear reasons why an owner or operator can have confidence that the bulk of the funding for a selected project will be forthcoming at a later date." CURC recommended a reduction below the 81 percent CO_2 capture level, which it described as "not a reasonable approach" at this stage of technology development or integration. "Industry needs to obtain baseline data, demonstrated reliability and widespread confidence in CCS systems and these goals can be achieved more cost-effectively by requiring less aggressive percentages of capture."[177]

CURC also wanted more flexibility in the CO_2 storage site, a regulatory structure for CO_2 transport, a resolution of long-term liability issues, more favorable cost-sharing arrangements, including recognizing the parasitic energy loss as a cost, and modifications that made it clear that non-IGCC plants were eligible.[178] In a sum-

because of the numerous plant modifications necessary in an IGCC plant to capture and sequester CO_2, "the entire plant could be considered a stranded asset." Therefore, the entire cost of the plant could be included in the base for cost-sharing, as it had been in other projects were novel technology is being tested. *Ibid.*

[174] Letter to Rep. Tim Johnson et al. from Secretary Bodman, attached to "Memorandum for the Secretary" from C.H. Albright, Jr., to James Slutz, April 9, 2008.

[175] Despite requests under the *Freedom of Information Act,* DOE refused to release these comments or those submitted on the draft Funding Opportunity Announcement until this committee requested them. It provided no legitimate reason for withholding the comments beyond a claim that there was proprietary information in some of the responses. See, e.g., e-mail entitled "FG docs" from Andrew Patterson to Scott Shiller, Victor Der and James Slutz, March 31, 2008.

[176] IEA Greenhouse Gas R&D Programme, World Coal Institute and IEA Clean Coal Centre, "Summary Report on Expert Workshop on Financing Carbon Capture and Storage (CCS): Barriers and Solutions," May 28–29, 2008, pp. 2–3 and 8.

[177] CURC, "Comments related to the Department of Energy draft announcement #DE–PS26–08T00496 related to "RESTRUCTURED FUTUREGEN," May 21, 2008, pp. 2–3.

[178] *Ibid.,* pp. 6–7

mary of the unreleased "public" FOA comments, DOE indicated that they were similar to those submitted by CURC.[179]

The final FOA made some of those changes. A non-gasification project did not have to produce at least 250 MW net electricity output but could be at a "commercially viable size." There was no mandatory ceiling on the project cost. The applicants must "propose" start-up by Dec. 31, 2015, but apparently had no obligation to meet that date. The demonstrations were "expected" to operate for three to five years and capture one million metric tons of CO_2 per year that would be put in a saline "formation," not an aquifer as originally required. There was no obligation to operate after the demonstration period, and monitoring of the sequestration site would continue for only two years after the demonstration was completed. DOE would contribute the lesser of (1) the incremental cost of implementing CCS on the demonstration unit; or (2) 50 percent of the total allowable project cost. DOE's maximum cost would be negotiated prior to the award. Applications were due on October 8, 2008, with selections made by the end of the year.[180]

In the final FOA, DOE bragged again that "[t]oday, more than ever, the FutureGen concept holds great promise for sustaining near-term coal utilization."[181] Internally, staff saw it quite differently. The goals that Secretary Bodman had promised when he rolled out the restructured FutureGen were no longer mandatory. "The reality of Financial Assistance awards is that they should be viewed as "best effort," Keith Miles wrote.

> DOE asks for the Applicant to address all of the requirements (goals and objectives), provide a Statement of Project Objectives (SOPO) as well as the evaluation criteria in the FOA, which will ultimately be reviewed by DOE with selections made. Unfortunately there are no "consequences" if they don't achieve the goals and objectives contained in their SOPO. DOE's only recourse is when an issue of "noncompliance" arises, or research misconduct.[182]

No one—except those who may have drunk the Kool-Aid at DOE—was surprised at the anemic response to the FOA. In the end, almost no one came to DOE's party, and it wasn't the party that had been advertised in the invitation. There were four applications, two of which did not come close to meeting the criteria. Neither of the survivors proposed an IGCC/CCS plant, but hoped to test out experimental carbon capture technology on existing facilities. It was reported that even those applications were incomplete.[183] In January of 2009, Secretary Bodman and his deputies slipped out of town minus viable projects or even press releases claiming success.

Relationship with International Partners

Despite the years-long push to get other countries involved in FutureGen and the emphasis by high-level Bush officials on international participation in FutureGen, DOE did not discuss its change in plans with its international partners. Nor did it take any steps to inform the State Department's and its own international staff, which were continuing to solicit foreign partners. In a presentation to Brazil in October, FutureGen was described as a "unique opportunity to prove carbon sequestration . . . [and] to advance IGCC technology." International participation would facilitate implementation of CCS in emerging economies.[184] In November, Secretary Bodman, who had met previously with Polish officials, sent a letter encouraging Poland to join the initiative.[185]

In December, Treasury Secretary Paulson in a speech before the Asia Society prior to another SED meeting with China stated that the FutureGen clean coal development partnership with China represented one "of the best areas of on-going cooperation."[186]

When Karen Harbert, DOE's Assistant Secretary for policy and international affairs, asked how international partners could be incorporated into the new

[179] "DIFFERENCES BETWEEN RESTRUCTURED FUTUREGEN "DRAFT" AND "FINAL" FUNDING OPPORTUNITY ANNOUNCEMENT (FOA)," attached to e-mail entitled "FG Q&As for Final FOA.6–23–08.v4.doc" from Jarad Daniels to Keith Miles and Thomas Sarkus, June 23, 3008.

[180] DOE, *"Funding Assistance Funding Opportunity Announcement,"* June 24, 2008.

[181] *Ibid.,* p. 6.

[182] E-mail entitled "RE: Restructured FutureGen @ REMINDER COMMENTS DUE BY 10:30 AM" from Keith Miles to Jay Hoffman and David Pepson. June 23, 2008.

[183] "New Life for Clean Coal Project," *The Washington Post,* March 6, 2009, A1.

[184] DOE, *"FutureGen: A Path to Success: The Right Project at the Right Time,"* Oct. 17, 2007.

[185] Letter from Samuel Bodman to Piotr Naimski.

[186] Remarks by Secretary Henry M. Paulson, Jr. on "Maintaining Forward Momentum in U.S.-China Economic Relations," Treasury Department press release, Dec. 5, 2007, p. 2.

FutureGen, she was bluntly told that it had no international component.[187] But when Japanese officials sent a draft of a "framework" for a FutureGen agreement between the U.S. and Japan and a $10 million contribution on January 18, Harbert told them to "hold tight." Japan had hoped to have it signed in the next week at the World Economic Forum and had already put $700,000 in its budget for the project.[188] In the final draft of the supporting documentation for the restructured FutureGen, DOE removed all references to foreign governments' having access to test demonstration results because "they wouldn't have access to any of the 'good' proprietary information, but rather only the non-proprietary information which DOE always makes publicly available for any of projects anyhow."[189]

In a draft memo prepared for James Slutz to issue after the January 30 announcement, the partners were to be told, "The commercial market place will be the mechanism to deploy new technology such as Integrated Gasification Combined Cycle (IGCC) with CCS." DOE was, however, "committed to an international outreach component" which was "critical to garnering broad acceptance of the new technology and fostering the replication of the near zero-emissions on a broad scale." In other words, "thanks, but no thanks."[190]

On Feb. 1, 2008, Secretary Bodman sent out letters to all the current and potential foreign partners telling them that FutureGen was being restructured to emphasize commercial demonstration of CCS with IGCC plants, and that he looked forward to "continued outreach" to the interested countries.[191] The first—and most angry—response came from Korea. Kijune Kim of the Ministry of Commerce, Industry and Energy, wrote,

> I am really surprised that I had no prior explanation of that restructuring intention from DOE before . . . Korea really tried our best to cooperate with US to develop FutureGen project since early 2006 . . .. We contributed $2 million in March 2007 . . .. actively participated in four meetings . . . even hosted the third negotiating meeting for the FutureGen project agreement last October in Seoul to make the project move on. If you have recognized all Korea's endeavor regarding the project, it is not the appropriate way to deliver U.S. DOE's intention to restructure FutureGen project by sending me an e-mail . . . without any prior consultation or explanation to Korea.

Mr. Kim concluded by pointedly noting "that there were better ways (both procedure and timing) to inform Korea US DOE's intention to restructure FutureGen project."[192]

After the announcement, the State Department asked if DOE had talking points to use with foreign audiences. Norway and Russia had expressed interest in FutureGen; other embassies had pro-FutureGen points in their standard talks on energy and climate.[193] On February 1, 2008, David Mulford, the U.S. ambassador to India, wrote Secretary Bodman expressing concern about the FutureGen project based on his reading of media reports. "Since I will have to address the issue soon with the Government of India (GOI) and the Indian media, I would appreciate some clarification . . .. This would include the specific issue of the status of India's pledged monetary commitment." The ambassador reiterated India's ambitious plans to expand its all coal-fired thermal capacity and asked the Secretary for his views "on how to continue cooperation with India in clean-coal power generation technology and mitigation of related carbon emissions."[194] Australia also wondered what was up. "The restructuring of FutureGen has been a hot topic for our media," Australia's clean coal manager in the Department of Resources Energy and Tourism wrote. We have also been fielding representations from our own industry including

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[187] E-mail entitled "RE: Int'l aspects of new futuregen construct" from James Slutz to Karen Harbert, Dec. 12, 2007.

[188] E-mail entitled "FW: Signature for the Framework on FG Project between DOE and METI etc." from Jarad Daniels to Joseph Giove, Jan. 18, 2008; e-mail entitled "Re: FutureGen Framework Agreement" from Talashi Naruse to Joseph Giove, Jan. 21, 2008.

[189] E-mail entitled "RE: restructured futuregen international draft—comments requested" from Jarad Daniels to Bud Albright, James Slutz, Doug Schwartz, Adams Ingols, Kathy Fredriksen, Diana Clark and Raj Luhar, Jan. 25, 2008. At this point, India had contributed $4 million and South Korea had contributed $2 million. China and Australia had made formal commitments; Norway was ready to contribute funds; and Italy and Poland had stated interest. *Ibid.*

[190] "Draft Email from Jim Slutz to Staff Contacts in seven FG partner countries," undated.

[191] Letter from Secretary Bodman to the Honorable Akira Amari, Feb. 1, 2008.

[192] E-mail entitled "Re: DOE Announces Restructured FutureGen" from Kijune Kim to James Slutz, Feb. 4, 2008.

[193] E-mail entitled "FutureGen Talking Points" from Peter Haymond to Giulia Bisconti, Jan. 31, 2008.

[194] Letter from Mr. Mulford to Secretary Bodman, Feb. 1, 2008.

companies involved in the FutureGen Alliance . . .. [W]e need to get a better understanding of what this means in terms of the International Partnership and the associated agreement being negotiated with other Governments." [195]

In February, Secretary Bodman received a letter from the Australian minister for resources, energy and tourism, who—based on the September 4, 2007, joint statement by Prime Minister Howard and President Bush—was looking forward to "a program of consultation at both the government and industry level including the means by which information on technological advances will be shared." [196] Secretary Bodman responded with a letter stating that DOE "will continue to keep you informed of significant developments in the FutureGen program and look forward to future collaborations with Australia." [197] That appears to have been the end of any real effort for international cooperation on FutureGen, once a "core objective" of the project, although FE attempted through the spring to gin up interest. Its staff made presentations to various embassies claiming that the international component was a "key priority" in the restructured FutureGen with a focus on a "non-proprietary information exchange." [198] Their objective was to convey "the clear message that the U.S. commitment to clean coal remains stronger than ever under the restructured FutureGen." [199]

By the end of June, 2008 DOE claimed that it was still "exploring ways to engage governments in deploying Near-Zero Emission Coal plants with CCS for deployment around the world." It proposed workshops and symposia to share non-proprietary information and the development of global outreach strategies for acceptance of the technology and gamely claimed that all of the previously interested countries would "likely have continued interest" in the outcome of FutureGen.[200] Jim Connaughton, CEQ Chief and loyal Bush soldier, was quoted in the Indian press as saying that there would be three to four zero emission coal-fired power plants and even greater international participation in the restructured FutureGen, although there was no evidence that either one of those statements was accurate.[201]

Australia, however, went ahead on its own. After the fall of the Howard government, it ratified the Kyoto Protocol and established its own fund to pursue CCS demonstration projects in Australia.[202]

Peabody Energy, one of the FutureGen partners which already had a presence in China, signed an agreement in December of 2007 with China Huaneng Group to invest in an integrated gasification combined cycle power plant near Tianjin, southeast of Beijing called GreenGen, although there will be no CCS until its "later phases."

Abu Dhabi is designing an IGCC plant with BP and Rio Tinto that is supposed to produce hydrogen for energy and CO_2 to be sequestered.[203]

Conclusion

FutureGen began life as the centerpiece of the Bush Administration's climate change technologies. This initiative held out the promise of reducing greenhouse gas emissions without the pain of signing up to the Kyoto Protocols. In abandoning the original concept, the Department of Energy left the country with no coherent strat-

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[195] E-mail entitled "Re: FutureGen [SEC=UNCLASSIFIED]" from John Karas to Victor Der, Feb. 8, 2008.

[196] Letter from Martin Ferguson to Secretary Bodman, Feb. 22, 2008.

[197] Letter from Secretary Bodman to Mr. Ferguson, March 26, 2008.

[198] "FutureGen—International Component," attached to e-mail entitled "FW: FutureGen: International" from Victor Der to Jarad Daniels, Joseph Giove and Samuel Biondo, May 20, 2008.

[199] *Ibid.*

[200] DOE Office of Fossil Energy, "U.S. Carbon Capture and Storage Program: Where We Are and Where We're Going: Clean Coal, FutureGen, and CCS" and attachments, June 2008. This presentation was created by FE as part of a FutureGen "outreach and communications" strategy after a *New York Times* article said the entire clean coal effort was stalled. "Mounting Costs Slow the Push for Clean Coal," *The New York Times,* May 30, 2008, A1. "We will tout our investment and accomplishments as Connaughton has delineated and work them into the FE Clean Coal Exhibit," FE staff wrote. They would also visit the science attaches at the embassies in Washington and tell them about the restructured FutureGen. E-mail from Samuel Biondo to Joseph Giove, May 30, 2008.

[201] "Commercial viability of FutureGen to be known only in 2020," *The Hindu Business Line*, *http://www.thehindubusinessline.com/2008/06/18/stories/2008061851582100.htm* June 18, 2008.

[202] "Remember FutureGen?" *Columbia Journalism Review,* April 4, 2008; "Investment in Victoria's Clean Coal Industry," *http://www.investvictoria.com/300408VicCleanCoalIndustry*, April 30, 2008.

[203] "BP Says Abu Dhabi Hydrogen-Fueled Plant to Start 2013," Bloomberg.com, Jan 19, 2009. *http://www.bloomberg.com/apps/news?pid=20601130&sid=azs2rxpX_Sk&refer=environment*

egy for carbon capture and sequestration-despite having fingers in many pots. Whether the new Administration and Congress should revive the original program, which was ready to begin work when the Department of Energy killed it, or move to some other initiative, is an open question. It is absolutely clear that the "Plan B" initiative sold to the public and the Congress by Secretary Bodman will not provide the kind of long-term benefits to the United States and the world needed to deal with global climate change. The end result of this trail of mismanagement? Progress on the great challenges to harness technology to build a greener energy future was stalled, and the United States abandoned its global leadership role.

This is a disappointing legacy for the Department of Energy.

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