EXECUTIVE SUMMARY
(Fall 2009)
Clean Coal and CCS Technology Development Pathways Initiative
Participant Input

Senator Byron L. Dorgan believes that technology research, development, and demonstration (RD&D) are critical to resolve the twin challenges of energy security and climate change. Because a consensus on coal technology direction has been lacking in discussions about climate change, Senator Dorgan sought the opinions of a broad group of stakeholders regarding a strategic path forward for ensuring that clean coal and carbon capture and storage (CCS) technology is commercially available in time to contribute significantly to meeting these challenges.

Each of these expert panels was comprised of representatives from industry, academia, government, and non-governmental organizations and was asked to focus on a specific area or issue regarding the nation's path toward effective and economic CCS deployment. The areas and issues addressed included:

1. Funding Levels and Timelines
2. Financial Mechanisms
3. Industrial Sector Interests and Application
4. Addressing Economic Impacts
5. Administration and Implementation
6. Overcoming the CCS Penalty
7. Domestic and International Deployment
8. Metrics for Success

What follows is a brief summary of the deliberations and findings of each of these expert panels.

Funding Levels and Timelines

How much funding for clean coal and CCS is required to ensure that technology is ready for broad deployment (public and private commitments as well as R&D, demonstration, early deployment, full commercialization), and what are the appropriate timelines for such funding?

The group reached agreement on the basic phases that must occur to develop and commercially deploy CCS technology; however, various perspectives were identified on the timelines or funding profiles that would be required. As a result, several participating organizations developed and presented their own funding levels and timelines, based on their unique view of CCS technology maturity, estimated costs, public/private cost share, and expected future market conditions. These funding levels and timelines addressed the development of CCS technology

from R&D through its early commercial adoption – a period from roughly 2010 through 2035. It is important to recognize the group's response to this question does not represent a consensus; rather, it is intended to identify a range of options, some of which are preferred by particular participating organizations and not by others. A total investment to develop CCS technology, ranging from $110B to $450B for the period from 2010 to 2035, is proposed. This total CCS investment is allocated over the four phases of R&D ($5-$7B), Demonstration ($5-$25B), Pioneer Plants-First Movers ($20-$65B), and Early Adopters ($80-$350B).

Financial Mechanisms

What are the proper financial drivers needed to develop clean coal and CCS technology and to ensure broad deployment (appropriations, wires charge, tax incentives, loan guarantees, auction proceeds, etc.)?

A suite of financial mechanisms, including a price signal for carbon emissions, were identified. Available financial mechanisms analyzed included: Annual Appropriations; Self-imposed fees-legislatively approved [Wires Charge]; Investment Tax Credits; Production Tax Credits/CO_2 Sequestration Credits; Fixed "Feed-in" Subsidy (a form of direct cash payment under a cap and trade program); Direct Cash Payments; Federal Loan Guarantees; Federal Financing Bank.

The group did not recommend a universal funding mechanism applicable to all CCS projects, but rather suggested the need to tailor financial mechanisms appropriate to the stage of technology development, and sensitive to the dynamic conditions of the marketplace, with the intent to specifically avoid a "one-size-fits-all" strategy. The group universally recognized the need to ensure that the funding mechanisms selected, alone or in combination, must be sufficient to fully offset the incremental direct and indirect CCS costs experienced by a project.

> *Note: The first question of Senator Dorgan's CCS Pathways Initiative relates to the total cost required to ensure broad CCS deployment and when that cost will be incurred over time. The second question relates to the financial mechanisms or drivers needed to cover those costs and ensure broad deployment. In effect, these first two questions, taken together, ask "What will it cost to achieve broad CCS deployment, when will the money be needed, who should pay for it, and how will this be disbursed." To answer this, it is important to the reader that the two answers be considered together because the development and deployment of CCS and the funding options to achieve it clearly are interdependent.*

Industrial Sector Interests and Application

How can the impacts of carbon management be equitably shared across all sources of carbon (point sources – electric power, industrial, ethanol production, etc., non-point sources – transportation) so that one sector is not penalized to the benefit of another sector?

Development of CCS technology in the timeframe needed to meet emissions reduction goals requires it to be included with all other mitigation technologies. This strategy is the most

efficient path to empowering the development of new technologies, and the skills and manufacturing capability to design, build, construct, and operate these technologies.

Addressing Economic Impacts

What are the major economic impacts to industry (direct and indirect) with CCS and how can these impacts be minimized or deemed to be acceptable?

Today's commercially available capture and storage 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. Deployment of CCS upon the nation's power sector with today's technology will require an additional approximately 90 GW of replacement power to accommodate its 30 percent parasitic power energy penalty. With aggressive technology development, cost can be reduced to a 10 percent increase in the cost of electricity for new gasification-based energy plants, and to less than a 35 percent increase in the cost of electricity for pulverized coal-fired power plants.

Administration and Implementation

How should such a program be administered and implemented, and what Federal organizations (DOE, IRS, and Climate Change Technology Board) and private organizations should be involved?

There are several approaches or combinations possible of a Congressional appropriations model and/or a Trust Fund model in funding further CCS technology research and large-scale demonstrations. Congressional appropriations could be as proposed in Title VII of EISA 2007 with DOE implementing and administering the program. A Trust Fund model could be similar to that proposed in H.R. 6258, Carbon Capture and Storage Early Deployment Act, introduced by U.S. Representative Rick Boucher in the summer of 2008. Various Federal agencies would become involved across the CCS chain in the administration of CCS projects, including the Department's of Energy, Transportation, Interior, and EPA and several state regulatory organizations.

Overcoming the CCS Penalty

How can the United States ensure that it will not be penalized by aggressively pursuing CCS technology to the benefit of developing nations who may not deploy CCS anytime soon?

While economic risk management must be addressed, it is also critical to view CCS as a competitive technology development opportunity, with a view toward gaining first-mover advantage. A threefold approach was offered as a mitigation strategy to thwart the potential for economic penalty to the U.S. caused by our early adoption of CCS. The approach suggested the U.S. 1) develop technology through Federal government/private pilot partnerships in a manner that involves as much private industry as is feasible and brings technology to scale more quickly than proposed in previous government projects; 2) target potential adversely affected consumers and either compensate for or diffuse the costs by not tying CCS to a particular industrial or

residential consumer power base; and 3) focus international negotiations with China on winning agreement for some percentage of clean coal requirement, encourage the U.S. to pursue these negotiations in partnership with other developed nations, and ensure the creation and enforcement of intellectual property rights, respectful of all parties involved.

Domestic and International Deployment

How can CCS technology and deployment be moved faster in the United States? How can the United States more rapidly expand its cooperation with other key coal producing and using nations to hasten international use of this technology?

The fastest route for deployment is an incentive structure for immediate deployment of present technology, and an R&D program to further improve and continue development of this technology. A program of 10-12 large-scale demonstrations projects is critical. It is also important for the U.S. to build on its dialogue with major emerging economies to develop joint strategies for R&D and deployment of CCS in their markets. Large emerging CO_2 emitter countries like China and India also need to develop the knowledge base and experience to manage CO_2 in geologic formations, recognizing CCS as a globally practical option. Indemnification from long-term liability for the first few projects should be provided. Once formal regulations are in place and the large-scale demonstrations are underway, aggressive funding programs will still likely be needed to spark widespread deployment.

Metrics for Success

Each panel was asked to also address, discuss, and identify metrics for success during its deliberations. This issue was framed by the question "How do we measure benchmarks and track successes?"

Broad consensus among the panels indicated that, although it is extremely important that a common set of global guidelines be established, in order to determine current baselines and to measure progress on a nation-by-nation basis, currently there is no globally acceptable methodology for independently measuring the success of commercial-scale CCS projects. The panels also agreed that no uniform standards exist that address who, how, when, or where monitoring, verification, and accounting (MVA) are to be performed or audited to ensure permanence. The panels did suggest that the following benchmarks be considered to track U.S. and global progress in reducing CO_2 emissions:

- Power plant efficiency improvements
- Tons of CO_2 injected and stored
- Number of integrated power-CCS commercial-scale demonstrations
- Adjustment in mix of energy resources being used
- Net effect on gross domestic product