

**Clean Air Act Advisory Committee
Advanced Coal Technology Work Group
January 8-9, 2007
Double Tree Hotel (Crystal City)
Arlington, VA**

Day 1: Monday, January 8th

Opening Remarks

Rob Brenner, U.S. EPA, provided opening comments and thanked the group for its attendance. He expressed his confidence that the work group process would be worthwhile and explained that technology is a major element of Clean Air Act implementation. Technologies have been developed or improved because of the Clean Air Act, which has been critical for public health measures. Mr. Brenner explained how it is difficult to put programs in place unless technologies exist or are on the horizon. While EPA has used pilot demonstrations, performance standards, emissions fees, and market based systems, the challenge remains to secure energy and focus on public health. Mr. Brenner added that the group all knew that we will be using a lot of coal in the next few decades, so it is important to make sure we are prepared with the appropriate technologies. He noted that if we cannot develop the technology to use coal cleanly, we do not know what alternatives remain. Using coal cleanly is important for public health and energy security, so it is important to decide what the right tools are to use to accelerate the pace of advanced coal technology development.

Mr. Brenner provided an analogy to the automobile industry, where there used to be concerns about technology development. He said that we have come a long way within the last decade in the auto industry since there is now competition between hybrids, biodiesel, etc. The question remains about whether this can happen in the coal sector, but the work group must now try to pick up the pace. He added that in order for the work group's recommendations to be successful, the group must develop suggested actions for each of the stakeholder groups. Since coal is more than just an environmental regulatory issue, recommendations are needed beyond those sent to EPA. Recommendations must make sense for NGOs, environmental groups, power generators, coal companies, states, federal agencies, public utilities, and many others. The work group should be concerned with providing a set of recommended actions for all of these groups, where the whole is greater than the sum of the parts. Mr. Brenner concluded by thanking the group for participating.

Ben Henneke, Clean Air Action Corporation, said that we make a difference as a work group and we will deliver a final report in one year to EPA. He added that everyone was there to produce something useful; as a work group we can decide to create useful insights and useful recommendations for those with authority to write and implement laws. He concluded that there is an aggressive schedule with monthly meetings.

Introductions

Facilitator Laura Bachle, U.S. EPA, asked that during introductions the members do not go over their time. She told members to state their name so people get to know each other. She asked everyone to be respectful of other people's time and be solution-oriented in their comments. She also asked that everyone please put their cell phones on mute to keep interruptions to a minimum. The members of the work group introduced themselves and mentioned the expectations they had of the work group. Below is a list of these expectations of the work group:

- Create useful recommendations and insights for decision makers
- Address a convergence of factors to discuss issues face to face (timing is good, people are open to ideas and solutions)
- Have impact collectively on how to burn coal cleaner and advance technology
- Integrate concept of carbon sequestration
- Improve air quality
- Find out how to solve the "but" problem and capitalize on opportunities that exist
- Learn from each other
- Understand the questions
- Keep options on the table
- Learn more about what we know now
- Discuss how we can use our coal resources and protect the environment
- Look at all kinds of coal technology
- Consider potential regulations for Integrated Gasification Combined Cycle (IGCC) and carbon sequestration
- Discuss health protection
- Discuss what technology and public policy can and cannot do
- Improve the permitting process

Overview of Meeting Agenda and Outcomes

The facilitators, Pat Tallarico, SRA International, and Ms. Bachle provided an overview of meeting objectives. The first was to share information and provide a preliminary foundation for understanding topics to be discussed by the Advanced Coal Technology Work Group. The second was to identify and discuss expectations and outcomes for the work group process.

Ms. Bachle said that the schedule would allow for plenty of time to discuss the presentations with time allotted for questions and answers. She added that each table had pads of paper to jot down other questions or other areas for further discussion that the presentation prompted. She said that Mr. Tallarico would pick up the notes and post them on the wall.

Mr. Tallarico added that the notes could lead to other topics that need to be explored. Additional questions about that topic could be discussed at future meetings. He mentioned that the schedule will include time for organizational issues, including process and substance. The group will also discuss the draft charter.

Overview and Discussion of Advanced Coal Technology for Electric Power Generation

John Novak, Electric Power Research Institute (EPRI), introduced Stu Dalton, EPRI, on the phone. Mr. Dalton was to speak about current and future power plant opportunities, characteristics of coal and the implications for coal technology, different types of advanced coal technology, and implications of these technologies. EPRI is an objective non-profit technology development research corporation. The organization has over 700 members and funders, many of whom were, in fact, present at the Advanced Coal Technology (ACT) work group meeting. This group includes a broad range of stakeholders, private companies, governmental organizations, and advisory councils. EPRI does not do basic research; instead, the company focuses on moving primary researchers through technology development process in four different sectors: non-nuclear power generation, nuclear power generation, markets, and environmental-powered technologies.

A new program was developed within the company a couple of years ago called the Coal Fleet Research Group. This group has approximately 60 members and deals with advanced coal technology and CO₂ capture and storage.

Mr. Dalton introduced himself and explained that he would try to touch on a breadth of power company carbon management options, including every aspect of power generation and every option for a carbon-constrained future. Non-generation options include hybrid cars and super-conducting cables. In addition, CO₂-free resources include solar power, wind generation, and nuclear power. However, Mr. Dalton explained that he would speak mostly about high-efficiency CO₂-emitting and CO₂-capture technology from new or existing sources.

First and foremost, Mr. Dalton noted that coal is not uniform in nature, which has a significant impact on what technologies are best across the board for carbon capture. In some areas coal proves to be a good resource (e.g., low in sulfur), while in other areas, like Illinois, coal is high in sulfur and chloride, making it more difficult to handle. Carbon capture technologies have to deal with all of this variation. Younger coals (e.g., lignites) have a high amount of carbon, hydrogen, oxygen, and moisture. As coals progress, they start to have higher concentrations of carbon and less hydrogen (e.g., anthracite). Sulfur content and ash are highly based on what is present in the area when the coal was laid.

A map of the United States shows several different kinds of coal. The lignites in the Powder River Basin provide a challenge for gasification processes, but are easy to move as far east as Florida and Tennessee. The lignites in North Dakota and Texas have a very

different composition, which makes them harder to move. Texas coal is not even mined because of the inconsistent content.

This great variation in coal content is important for the gasification process. Technologies are developed for higher-ranked coals (e.g., coals drawing from Pittsburgh, P.A. and Illinois). The slurry gasifier developed by General Electric (GE) and ConocoPhillips, for example, is better with drier coals with a higher heating value because it works by burning the coal in oxygen and evaporating water. It is possible to gasify different types of coal, but this process is difficult with moist coals because energy is lost in the process, which reduces the economic value.

The coal consumption patterns in the United States can also be seen on a map. One important note is that the Texas lignite coal usage does not go as far to the east as the actual coal fields; the coal in the eastern fields becomes harder to use. Also, you will notice that Powder River Basin coal makes up about half of the total coal tonnage burned in the United States. Northern Appalachian coal is restricted to these areas because it has to be scrubbed before it can be used. Likewise, Rocky Mountain coal is high grade, which makes it very good for gasification, but it is also used locally. Places like Florida, which require longer transportation routes, import from Venezuela and South Africa.

Tony DeLucia, East Tennessee State University, asked whether Mr. Dalton knew if there was a correlation between coal consumption and state public health ratings. Mr. Dalton answered that he does not currently have any data about the effects of coal, because it would be difficult to collect such data. For example, different states have different emission control standards. Mr. Dalton did note that the amount of coal used should be proportional to the amount of CO₂ released.

The total cost of first of a kind (FOAK) plants has been increasing for many different types of facilities. In particular, Integrated Gasification Combined Cycle (IGCC) plant costs are up significantly. FOAK IGCC plants costs are 20% higher than what was originally expected. Ed Ruben at Carnegie Mellon developed a cost curve to measure capital cost of new coal technologies over time. This curve represents the different stages of technology development. Mr. Ruben found that companies make aggressive claims about costs early on without any data to support these claims. As more information surfaces, costs increase. The capital costs per unit of capacity then begin to decrease over time as a company deploys more units. This model has worked in the case of NO_x reduction technologies, SO₂ capture, and pulverized coal plants. Based on this model, IGCC plant cost estimates are 15-20% greater than pulverized coal plants; these costs do not show signs of coming down.

Several recent reports from large corporations have reported extremely high costs. Pulverized coal plants and chemical plants have also followed this trend of increasing costs. Mr. Dalton believes that these increases are a result of increased competition.

Mr. Dalton then presented an emissions comparison on a lbs/megawatt-hr output basis. These units are helpful because if improvements are made through efficiency, these

improvements are reflected in lower lbs/megawatt-hr unit. Mr. Dalton's graph shows that Natural Gas Combined Cycle (NGCC) + Selective Catalytic Reduction (SCR) plants, IGCC + SCR, IGCC, and supercritical pulverized coal (SCPC) +SCR plants all have lower emissions than the New Source Performance Standards require.

Currently, new plants are faced with the challenge of reducing the costs of gasification, integration, hydrogen turbines, and CO₂ storage. In addition, the cost of capture has become a large issue. The bottom line is that CO₂ options require both gasification and combustion technology.

A well-developed system for CO₂ removal requires a few basic steps: (1) a well-controlled boiler; (2) a pulverized coal boiler; (3) an SCR; (4) an electrostatic NO_x control; (5) an electrostatic precipitator (ESP) or a bag house for fly ash control; and (6) a flue gas desulfurization (FGD) unit. CO₂ capture requires money, space, ultra-low SO₂, and a lot of steam energy.

One large problem with these technologies is that there is an inverse relationship between efficiency and percent CO₂ reduction. The efficiency increase from a subcritical plant to an ultrasupercritical plant can yield up to a 25% CO₂ reduction. Mr. Dalton noted that efficiency can get a plant to a certain level of CO₂ reduction, but NGCC is much more effective at reducing CO₂.

Gasification technology exists commercially and consists of (1) an air separation unit (ASU); (2) a gasifier; (3) gas clean-up; and (4) power block. FutureGen has proposed a system that employs the same steps, but adds a commercial chemical shift reaction between CO and steam at high temperature. This reaction takes place in a shift reactor to produce gas CO₂ and hydrogen. Once the CO₂ is removed, just hydrogen remains.

The major difference between gasification and combustion is that different reduced species are removed. Gasification has many advantages, including the ability to produce electricity, fuels, chemicals, fertilizer, and hydrogen.

Currently, there are two coal IGCC power plants in the United States (Wabash River in Indiana and Polk Power Station in Florida), there are three non-power facilities using IGCC technology. In addition, there are some conventional plants with relatively small capture systems to make food-grade CO₂. EPRI is also involved in a project to develop a 5 MW chilled ammonia CO₂ capture pilot, slated for completion in the end of 2007.

Other ideas that are very early in the concept development stage include (1) RTI's post-combustion CO₂ capture thermal-swing process using dry, regenerable sorbents; (2) the ECO₂ process with a CO₂ capture stage; and (3) CO₂ capture by O₂/CO₂ combustion, which uses three times more oxygen than IGCC.

The cost of electricity with capture economic analysis shows that all of the technologies listed are fairly competitive and within the same range of error. EPRI's recent report using Powder River Basin coal shows that SPPC is cheaper *with* capture than IGCC. Both

the costs and 20-year levelized cost of energy did not go up as much as IGCC, which makes EPRI question the use of IGCC on western coal, even with carbon capture.

Bruce Rising, Siemens Power Generation, asked about the breakdown in hr/kilowatts between a base plant and the environmental controls part of a plant. Mr. Dalton answered that EPRI's 1014510 report has the cost of every portion of the plant laid out, which was cross-compared with other sources. This report is available on www.epri.com.

A member of the audience asked whether the costs of IGCC in the slides represent this technology with or without SCR. Mr. Dalton answered that this information is presented without SCR.

The same member asked about the commercial availability of IGCC. She has heard conflicting information about EPC guarantees for this technology. Mr. Dalton commented that available guarantees vary by supplier. For example, when GE bought the gasification business from Chevron/Texaco, the utility industry was encouraged because these guarantees would now be available. It is still unclear what is involved in this guarantee. For example, 10% of the price of the overall contract can be kept in reserve for lack of performance. Additionally, before companies will make a guarantee millions of dollars have to go into front end engineering design.

John Thompson, Clean Air Task Force, asked about recent permit information. Mr. Dalton answered that he did not have time to cover this information in the presentation, but that he does have some information on permits from public documents. There are, however, permits that exist even though there is not an actual gasifier present.

A member of the audience noted that in the last four months, there have been five IGCC permit applications filed using Selexol, half of which were information collection requests (ICRs). The member wondered how much of Mr. Dalton's anecdotal information was geared toward Selexol. Mr. Dalton answered that a fair amount of this information is driven by these factors. For example, Selexol produces a lower sulfur content. However, if gases need to be pre-treated from a conventional combustion, special permits are required (including a permit for post-combustion removal). Mr. Dalton did acknowledge that a lot of permits are being driven by Selexol and the capability to go to a lower sulfur level.

The same member asked a question about the Texas study. He wondered whether this study factored in Siemen's purchase of Future Energy and the resulting dry feed technology. Mr. Dalton reminded the member that Shell is the best company for Powder River Basin coal technologies; GE would most likely decline a bid for this coal because they have not developed technology for water evaporation yet. Mr. Dalton acknowledged that new technologies coming down the pipe are promising, especially for GE, but these technologies need to be transferred to different coal types. For example, the transport gasifier being developed by the city of Orlando looks promising for Powder River Basin coal.

Greg Schaeffer, Arch Coal, Inc., asked about how these technologies operate in the higher elevations in the western states. Mr. Dalton answered that EPRI has worked on this issue for a while. Additionally, the Energy Policy Act of 2005 required that companies look at gasification technologies at high elevation. These studies found that at higher elevations, the power in the combustion turbine is lost. There are other regional issues, such as water availability.

Judi Greenwald, Pew Center on Global Climate Change, asked about the \$3,300 figure from Duke Energy. She wondered whether the company had made poor choices and whether we can learn from their mistakes. Mr. Dalton noted that many people have shown concern about these Duke figures and the fact that these technologies are not as far down the learning curve as people had once thought.

Maha Mahasenan, Rio Tinto Energy America, asked whether the \$3,300 figure by Duke Energy was a TPC or TPR estimate. Mr. Dalton responded that EPRI is unsure at this time because the information was gathered from a press announcement. He suspects that this cost does not include construction, but that it may include site costs. Mr. Novak also noted that the group would be hearing about price reduction on the following day.

Mr. Thompson recognized that EPRI has been very active in first generation IGCC plant development. He asked whether the company had done any research into CO₂ retrofit issues. Mr. Dalton responded that EPRI has a research and development plan for retrofits. The organizations that fund the EPRI work get specific information on design guides, although EPRI can distribute general information on retrofits.

Overview of Carbon Capture & Storage (CCS)

Julio Friedmann, Lawrence Livermore National Laboratory, presented the following topic: “Overview of Carbon Capture and Sequestration: Current Status, critical gaps, and recommendations for deployment.” Carbon capture and sequestration (CCS) requires the sequestration piece. He explained that everyone already knows a lot about carbon capture (i.e. expenses), but not as much is known about sequestration (even though the cost is inexpensive). Sequestration has grown in prominence because there is a lot of opportunity to do it, as evidenced by the map on the first slide that shows areas where there is substantial volume for storing CO₂. Mr. Friedmann added that everything we know strongly supports sequestration as a technology. There are some science and technology gaps that appear to be resolvable. There are also regulatory, legal, and operational concerns (including operational protocols) which need to be advised by scientific inquiry. Nonetheless, large-scale tests are crucial for understanding the technology, but no test to date is sufficient, which is grounds to proceed with the study.

Mr. Friedmann continued with more background information on CO₂ emissions. The CO₂ curve on slide 3 showed an increase in emissions and fuel use, which suggests why action is necessary. Mr. Friedmann said that even if all future power generations came from zero utilization, a large amount of carbon would still exist, which is why sequestration is important. Fortunately, the climate science community has come to a broader consensus

and a greater sureness on the need to take action. Major policy shifts and major industrial changes reflect a change in attitude towards carbon emissions and energy trends. With these policy and industrial shifts, the emergence of CO₂ markets can be expected.

Mr. Friedmann argued that CCS is worth doing, especially because using sequestration can bring us close to total potential abatement. If sequestration works, there will not be much change needed in terms of supply. If sequestration does not work, the entire energy framework needs to change. He added that from everything we know, CCS appears at once an actionable, scaleable, relatively cheap, bridging technology. He explained that sequestration involves a process of capturing CO₂ from point sources and putting it underground. Large targets include saline aquifers, depleted oil and gas fields, and unmineable coal seams. The cost of capture appears competitive today, compared to alternatives. Mr. Friedmann summarized that CCS provides opportunity for substantial and substantive abatement at an attractive and affordable cost.

Mr. Friedmann explained that sequestration can be done with a post-combustion fit, gasification and shift reaction, or oxyfiring combustion technology. In terms of capital and operating expense combined, these options are similar. On a thermodynamic basis, these options are also similar; one size will not fit all. He added that it is not obvious what the effluence streams will look like for each option because there is no simple handoff that happens between this step and storage.

Mr. Friedmann continued with background information on storage. The earth's crust is well configured to handle CO₂. Once underground, the CO₂ is trapped residually. A substantial fraction in any given reservoir can trap CO₂. Over long time frames, the CO₂ begins to dissolve in the fluids. Eventually, the CO₂ mixed with the water becomes dense, sinks, and results as a permanently bound carbonic acid. The trapping mechanism also occurs with coals, which often frees methane. If a poor reservoir is chosen, the CO₂ will be trapped until it is physically bound.

Several large projects exist around the world, with many pending. The projects demonstrate the high chance of success for CCS. However, Mr. Friedmann explained that since these studies are still not sufficient to provide all of the answers we need, there is room for more study and investigation. The Sleipner Vest project demonstrates first order viability of commercial storage. The project exists because Norway has a carbon tax on industry; taxes for carbon are \$50/ton C, while the cost of carbon storage in Norway is only \$15/ton C. Monitoring at Sleipner Vest supports the interpretation that CO₂ can be imaged and has not escaped. The Weyburn Project involves transport from a North Dakota gasification plant to an EOR field. This project has resulted in the injection of 1 million tons of CO₂ a year underground. The project developed a geological model, including time-lapse seismic surveys, and a 200 km radius was studied to get a sense of the risks.

In the United States, small projects have begun, and large scale projects are on the horizon. Two small pilot projects have begun in Texas and New Mexico. The Department of Energy (DOE) has decided to replicate these experiments with regional partnerships

and demonstration pilots throughout the country. Planned larger projects are in the works, including FutureGen, EXCEL, and BP (which should be online by 2012). Mr. Friedmann explained that while regional partnerships are expanding, the effort we have in the US needs to grow.

Mr. Friedmann then presented the scenario that one 1000 MW plant with 6 million tons of CO₂ put underground per year is the same as a 100,000 barrels a day. Over the 50 year life of a power plant, it will put 2.5 billion barrels of CO₂ underground. The plume will be 30 km (a substantial footprint). To get one gigaton of carbon abatement, you would need 600 projects of this size. He said that this shows that the true scope of large-scale CCS deployment is the primary challenge and source for concerns. To address CCS challenges, DOE initiated an ambitious program that includes FutureGen, research and development, and regional partnerships. Mr. Friedmann said that the budget for the DOE Clean Coal Program is \$67 million per year, while other major oil companies are spending as much or more.

Issues related to deployment, including choices made by operators and decisions made by regulators, are critical aspects of CCS that are still being discussed. Tasks, actions, and decisions must be in place to make deployment of CCS technology function appropriately. However, Mr. Friedmann explained that not everyone involved is clear on all of the actions and decisions. For example, how do we choose a site and what do we need to know about it? Also, once you have stopped an operation, what do you have to do after that? He said that these are questions that need to be clearly answered for operators and regulators.

Site selection involves a review of a site's injectivity, capacity, and effectiveness. Even though the tools to determine site characterization exist, the operational protocols are missing. There is no set of standards of regulatory framework that answers the questions. Co-containment storage may reduce COE and capture costs, but the effects are site specific. Once injection begins, measurement, monitoring, and verification (MMV) is required. Fortunately, there are many tools available for MMV and active monitoring. Effective MMV should include site assessment, baseline mentoring before injection, and general monitoring.

Mr. Friedmann added that concerns over leakage remains. There are places where CO₂ won't leak, but there are also risks. These risks can be prioritized, including zones with high permeability, wells and faults. Older wells with plugs are especially worrisome, but there has been no determination on what is an acceptable risk. For example, what is a proper abandonment protocol? When does liability transfer to a new party? And what are the real magnitudes of these risks?

Mr. Friedmann explained that work remains to develop a hazard risk framework that can be regularly employed that can both identify and quantify risks. The probability and consequence of risks must be considered. Because of the local nature of hazards, prioritization is possible for any case. Mr. Friedmann explained that risks at present appear to be small and manageable. He noted that we have done natural gas storage in the

U.S. for 100 years, so there is plenty of experience with the tools and methodology. If the site is chosen well, the risks are extremely small. He added that faults are another place CO₂ can leak, but surveys suggest that fault leakage flux rates are extremely small.

To conclude, Mr. Friedmann stated that large-scale tests are crucial to understanding the deployment of CCS and creating appropriate policy and economic structures.

After the presentation, members of the work group began to ask questions. Marty Smith, Xcel Energy, asked how to categorize all of the CO₂ that is being injected for EOR purposes in Texas. Mr. Friedmann responded that the biggest EOR projects have spot-on volumes that provide lessons from the operational perspectives. He added that the goal is to get oil out of the ground and there have been no studies recently on where the CO₂ goes with EOR. He noted that the monitoring on the EOR programs has been very limited.

William Auberle, Northern Arizona University, asked for further clarification on the footprint. Mr. Friedmann responded that the footprint is an illustrative example, and that the footprint at the surface could be quite small, while the subsurface footprint could be quite large.

Tony DeLucia, East Tennessee State University, asked about the costs associated with the IGCC scenarios needed to get to the 15% utilization rate for CCS. Mr. Friedmann responded that it is important to look at the situation with sequestration as an option versus not as an option. Without sequestration as an option, estimates are 30-50% higher.

Without any further questions on the presentation, the meeting was adjourned.

Day 2: Tuesday, January 9th

Summary of Day One and Overview of Day Two

Pat Tallarico, SRA International, began day two of the Coal Technology work group meeting by presenting the main ideas and highlights of the work group comments that were posted on the wall throughout the previous day's meeting. He said there were questions about additional analysis and evaluations of coal technologies (i.e., if technologies have been tested under certain conditions or certain types of coal). Additionally, there were questions about what technologies work and what technologies don't work, and what technologies need to be developed. There was also a suggestion to talk about new CO₂ management options in addition to carbon sequestration. Lastly, there was a question about taking transmission issues and transportation issues into account when siting facilities in relation to mines.

Mr. Tallarico next provided an overview of that day's meeting. There would be 3 to 4 speakers in the morning and in the afternoon the work group would focus on process, specifically how they talk about it and when they talk about it. He also said they would layout a plan for upcoming meetings and discuss products which they hope to develop.

Mr. Tallarico lastly introduced new work group participants who did not introduce themselves the previous day.

Rick Bolton, Center of Toxicology & Environmental Health, L.L.C., is the director of air quality services at his organization and has spent 24 years on the State of Tennessee Air Pollution Control Board where he has served 8 years as chairman. He has been on the Clean Air Act Advisory Committee (CAAAC) for the past 3 years.

Simon Mui, EPA Office of Transportation and Air Quality Transportation and Climate Division, said his office is interested in coal to liquid issues as well as the electrification of the transportation sector.

Lastly, Frank Blake, American Electric Power (AEP), introduced himself and said he was substituting for John McMannus also of American Electric Power.

Federal and State Incentives Related to Advanced Coal Technology

Federal Incentives

David Berg, DOE Office of Policy and International Affairs, worked at the EPA twenty-five years before coming to the Department of Energy. He introduced his presentation, *Federal Incentives Provided by EPA Act 2005 for Advanced Coal Technology*.

Mr. Berg reported that the Energy Policy Act (EPAct) provided a toolkit of incentives for a range of energy technologies and locations. The toolkit allowed the federal government new authorities to more robustly participate with states in encouraging the use of new

technologies, including coal. He emphasized that the federal government would target specific risks rather than simply provide co-funding.

Mr. Berg reviewed the work that had been completed to date. He stated that the report “The Business Case for Commercial Deployment of Integrated Gasification Combined Cycle Power Plants,” sponsored by DOE, EPA, and the Electric Power Research Institute (EPRI), was complete. An additional report, “The Business Case for Coal Gasification with Co-Production,” was in progress. He explained that the studies evaluated business risks and the value of potential incentives in improving cost of electricity and cost of rate of return. Both analyses suggested that, with incentives, commercial prospects were bright for both technologies.

Mr. Berg explained that the incentives were hoped to help implement the President’s “Advanced Energy Initiative” detailed in the State of the Union speech last year. He noted that the incentives covered energy efficiency as well as expansion of the energy source portfolio.

Mr. Berg stated that the toolkit would encourage the private sector to invest in the use of these technologies. Ideally, the toolkit would be used commercially and would promote government and industry collaboration.

Mr. Berg displayed a graph of risk over a plant project’s timeline. He explained that for many large, capital-intensive projects, the risk of the project was greatest early. This could be due to first-of-a-kind plants (FOAK), plant overruns resulting from underestimating cost to build, or other factors. Later in a project, the risks declined. He noted that the toolkit addressed risk mitigation for issues early in a plant’s life so that plants would actually get built.

Mr. Berg stated that the EPAct authorized \$1.65 billion in tax credits for clean coal projects, falling into three categories:

- IGCC (18 applications received from 19 states)
- Advanced Combustion (4 applications received from 19 states)
- Gasification (27 applications received from 17 states)

He reported that \$1.0 billion of tax credits had been awarded; the other \$65.0 would be distributed in 2007. He clarified that the tax credits were investment tax credits; depreciation rules applied.

A member of the Advanced Coal Technology (ACT) Work Group asked why the credits were broken up between 2006 and 2007. She noted that there were enough applications to use up the full amount of tax credit money. Mr. Berg responded that he did not know; it was not stated in the public statement. The Work Group member asked why tax credits were only awarded to IOU’s. Mr. Berg responded that he did not know that either. He stated that there was no clarification given on these questions, but maintained that they were excellent questions.

A second work group member observed that only one out of seven of the tax credit awards went to a state with a democratic governor, even though several democratic states applied. He did not see any rationale to the award process, which left him with the impression that there was a political edge to the decision making.

Mr. Berg thanked the member for his comments and continued the presentation. He stated that Title XVII authorized the Secretary of Energy to issue loan guarantees for various innovative technologies related to the avoidance, reduction, or sequestration of air pollutants and anthropogenic emissions of greenhouse gases. He clarified that projects in the R&D phase would not qualify; projects must be truly commercial.

In addition, Title XVII limited the guarantee to no more than 80% of the project cost of the facility. There was a preference for limiting guarantees to 80% of 80%. Mr. Berg explained that, at this point, DOE could not issue a loan guarantee even though it was authorized, because the Federal Credit Reform Act said there had to be authorization and appropriations stature. He stated that the borrower could obtain a credit subsidy cost.

The work group member asked for clarification on credit subsidy costs. Mr. Berg explained that if there was a 10% probability of default, then the government had to charge a credit subsidy cost amount that reflected that 10%. That way, the government ended up in a revenue neutral position and did not waste tax payer dollars on projects that were poorly conceived.

A work group member asked if the guarantee was based on the original loan value. Mr. Berg responded that yes, it was based on the original loan value.

Mr. Berg explained that the project sponsor must pay DOE for the administrative costs of issuing the loan guarantee. He said these were minor administrative costs in comparison to the loan itself; it could cost about \$1.0 million for DOE to do all the due diligence and oversight.

Mr. Berg displayed a list of the ten project categories that could be eligible for loan guarantees. He pointed out that there was a wide range of eligible technologies.

Mr. Berg reported that there were additional limitations when DOE issued the Title XVII guidelines last August:

- Quantitative limit of 2 billion
- Two categories eliminated from the first round
- Closing date extended from November to Dec 31

A work group member asked if the specific projects mentioned in Mr. Berg's presentation were included in the \$2.0 billion and if those projects applied. Mr. Berg responded that those projects would have to apply and be subject to the same criteria.

Mr. Berg highlighted the values of a loan guarantee to applicants, including short debt tenors (15-20 year debt instead of 5-7 years) and more debt leverage.

Mr. Berg briefly reviewed other incentives for clean coal. He then reiterated three “bottom lines” of his presentation:

- 1) Using incentives that align with specific business risks associated with a clean coal project will help the government encourage and accelerate commercial adoption of advanced coal technologies more efficiently.
- 2) Collaboration between Federal agencies and States is essential to achieve mutual objectives and reduce overlap.
- 3) Wall Street is hesitant to invest in FOAK plants without Federal support. It is therefore imperative for policy-makers to risk-align incentives and collaborate between levels of government.

A work group member asked if any money was going to carbon capture and sequestration (CCS) projects under the programs. Mr. Berg responded that it remained to be seen to see if any money would go to CCS; they were still reviewing pre-applications. The member asked if there were tax incentives for CCS projects. Mr. Berg did not know if sequestration was embedded in any of the programs, he offered to have someone get back to the member with that information. He stated that Pilot projects would involve sequestration, and noted that Julio Friedmann provided a description of those projects yesterday.

State Incentives

Kate Burke, National Conference of State Legislatures (NCSL), introduced her presentation regarding state incentives and directed those interested in more information to the National Conference of State Legislatures website: www.ncsl.org.

Ms. Burke reviewed states with existing incentive plans and explained that she would provide a brief overview of each state.

Colorado

Ms. Burke stated that a 2006 bill to approve development of electric generation abilities in Colorado required project applicants to demonstrate the use of IGCC technology. Projects could not exceed 350 MW and must also include the methods to monitor the fate of CO₂.

Kansas

Ms. Burke reported that tax credits for the development of new coal gasification facilities in Kansas were approved in May 2006. She explained that the tax credit would be taken in 10 annual installments, beginning in the year the facility went into service (or the year the facility was expanded).

Kentucky

Ms. Burke reported that Talina Matthews, Governor's Office of Energy Policy in Kentucky, would address Kentucky's incentive plans in more detail.

Illinois

Ms. Burke outlined Illinois's Opportunity Returns Program. She noted that the State could provide assistance up to \$300 million in bond funds for new gasification facilities. One such facility, the Taylorville Energy Center, was to be built in southern portion of state, bringing hundreds of jobs and economic development to the region.

Ms. Burke highlighted additional grants, including the "High Impact Business" program for facilities that generate 400MW energy and create jobs, noting that Illinois used the incentives largely to bring economic development to the state.

Indiana

Ms. Burke reviewed incentives from Indiana's 2002 and 2005 legislation, including the Coal Gasification Investment Tax Credit. Additional legislation promoted research of coal bed methane as a renewable energy source. Finally, she reported that The Energy Center at Purdue University was conducting research to develop clean fuels and electric energy.

Minnesota

Ms. Burke noted that a 2003 statute provided incentives for a proposed Mesaba Energy gasification plant in Minnesota.

Ohio

Ms. Burke briefly reviewed various incentives for Ohio, including loans, grants, tax incentives, and funding for demonstration projects.

Pennsylvania

Ms. Burke explained that coal constituted one of Pennsylvania's largest resources. She noted that Pennsylvania included coal methane and gasification in its portfolio, which was slightly different from other states. Pennsylvania also developed Energy Deployment for a Growing Economy (EDGE) to provide incentives to shut down old plants and restart new facilities.

Texas

Ms. Burke reported that the site for a FutureGen plant in Texas will be decided in fall 2007.

Wyoming

Ms. Burke clarified that Wyoming's sales and use tax exemption was limited to acquisition of equipment; it did not apply to tools used to build new facilities.

Ms. Burke reported that States with emerging action included Mississippi, New Mexico, Virginia, and West Virginia. She said that additional states had formed Sequestration Advisory Committees and noted that research on CCS was a continuing area of activity.

A member of the work group inquired about the specific research occurring in New Mexico. Ms. Burke responded that New Mexico was identifying ways to advance its technologies; she noted that the State was still in its very early stages of research.

Ms. Burke affirmed that the National Conference of State Legislatures was abreast of anything occurring in the state legislatures, including all aspects of energy, and urged the work group to notify her of any questions it may have.

A member of the work group recalled that Ms. Burke listed approximately one dozen State incentives for coal, while Mr. Berg mentioned that states and the federal government were working together. He asked how much independent thought states were giving to incentive programs. Ms. Burke replied that it depended on the state. Some states were waiting for the federal government to set incentive programs up; others were more integrated into the federal government's actions. In addition, some states set up incentive programs primarily to achieve economic development. She noted that more could be done to integrate state and federal efforts in this area.

Sandra Ely, New Mexico Environmental Department, expressed concern with a state's ability and likeliness to integrate incentive plans with the federal government. She noted that New Mexico specifically would like some help from the EPA. Ms. Burke responded that the Western Governor's Association was working in Denver as well. She commented that the process could be connected more closely.

Anthony DeLucia, East Tennessee State University, asked if the NCSL broke incentive efforts down by region regarding advice and tools. Ms. Burke responded that the NCSL tended to focus at the state level. However, she noted that several of the issues were beginning to be recognized as regional issues. She cited a climate institute sponsored by the NCSL that brought regional legislatures together. She explained that it began as a Midwest institute, but the issue grew so additional regions attended. She emphasized that NCSL did focused outreach.

Paul Bollinger, Air Force, stated that the types of incentives between states varied and asked if there was any consistency related to states' sequestration of CO₂. Ms. Burke responded that states looked to each other regarding research and development methods for carbon sequestration. She said the issue was gaining steam.

David Foerter, Institute of Clean Air Companies, noted that most of the incentives presented focused on new plants. He inquired about the carbon capture work being done for existing plants. Ms. Judi Greenwald, Pew Center on Global Climate Change, responded that work involving carbon capture in existing plants occurred more in the private sector; most of the incentives from the states and federal government applied to

new facilities. She explained that different people knew about capture and sequestration and emphasized the need for a more integrated approach.

Public Utility Commission's Perspective on Advanced Coal Technology and CCS

Talina Matthews, Governor of Kentucky's Office of Energy Policy (OEP), began her presentation by explaining that she would cover how public utilities are handled in a regulated environment. More specifically, Ms. Matthews said that she would address the challenges that face Public Utility Commissions (PUCs) and the most effective solutions to these problems.

Ms. Matthews has dealt with three different pilot carbon sequestration projects. In addition, she is looking forward to putting together an Appalachian energy plan with surrounding states in the near future. She is looking forward to an upcoming meeting which will bring together Appalachian "coal states" to cover this and other issues. Ms. Matthews suggested that the Advanced Coal Technology Work Group should get an invitation to this meeting. Kentucky is also part of the Southern State Energy Board, another interstate organization that handles these issues.

Ms. Matthews went on to stress that she does not represent a PUC, although she was once a PUC employee. Even so, the Kentucky OEP works collaboratively with the Kentucky Environmental Protection Cabinet, the Coal Council, and other State agencies to develop comprehensive strategies to advance energy policy in Kentucky.

The OEP's difficult mission is to implement the 54 recommendations of the Governor's Comprehensive Energy Strategy and to provide safe and reliable service at fair, just, and reasonable prices.

Kentucky is a traditional, fully regulated state with the obligation to provide power to any and all utilities in the state, including the state's 1.8 million customers. Even so, Kentucky is often classified as a "surplus state," meaning that it exports more power than it imports from outside; most of this power is exported to states to the north and east. Ms. Matthews noted that Kentucky may not have the lowest rates in the country, but that they are among the lowest. The state has seen extremely supportive investment opportunities and regulations, but the low prices are mostly a function of natural assets (i.e., "the coal under our feet").

The Public Service Commission (PSC) projected in 2005 that Kentucky will need an additional 7000 MW by 2025, based on a conservative growth rate and the notion that coal will maintain its position in the power generation market. Ms. Matthews believes that the state is well-equipped to handle this growth. Several regulated utilities across the state have already received certificates for supercritical pulverized coal (SCPC) units and coal-fired boilers (CFB). For example, PSC recently has issued an SPCP certificate to a utility which is expected to generate 750 MW of power per year.

In the past, Kentucky has been extremely supportive of advanced energy technologies. The Fuel Adjustment Clause can provide cost recovery for regulated utilities. In addition, the Environmental Surcharge allows companies to get money back when they start employing environmental control equipment. Regardless, the Certificate of Public Convenience and Necessity (CPCN) process tends to favor proven technologies and utilities that produce power at a lower cost. This situation creates a tension between encouraging the increased use of coal as one of Kentucky's natural resources and maintaining low electricity rates for the people of the State.

The State has tried to counterbalance this tension by passing legislation to allow rate recovery through a surcharge mechanism before and during construction of coal technology plants. Unfortunately, this legislation failed because voters claimed that the technology is unproven and that electricity rates would increase by more than 35% with the passing of the bill. Opponents stormed the capital, maintaining that the legislation would put tax dollars towards research and development. Proponents argued that these technological advancements should be made in anticipation of more stringent environmental rules. Ms. Matthews noted that lawmakers and coal technology proponents in regulated states should expect the same reaction when proposing such legislation.

Other states have tested alternative mechanisms for coal technology development. Ms. Matthews expressed a particular interest in Indiana, because it shares the same natural resources as Kentucky. In addition, Ohio and Illinois have used bonding. Another state has approved legislation to implement long-term contracts for synthetic natural gas with a clause for local distribution.

One member of the audience asked Ms. Matthews to explain bonding. Ms. Matthews said that Illinois, Ohio, and Indiana have a program that distributes state-financed bonds (not construction bonds) to utility companies that use coal technologies.

Judi Greenwald, Pew Center on Global Climate Change, asked why advanced coal technology incentive legislation has been so difficult in Kentucky. Have opponents made the same arguments in other states? Ms. Greenwald wondered whether the political environment in Kentucky did not favor this type of legislation. Ms. Matthews explained that politics were involved. Primarily, the legislation was seen as favoring companies which operate outside the state of Kentucky. Residents feared that this outside entity would reap the benefits of an internal investment. In addition, the legislation was brought the table soon after a utilities rate increase. Primarily, Ms. Matthews noted, coal technology proponents were not prepared for the aggressive opposition.

Tony DeLucia, East Tennessee State University, asked whether the legislative outcome was a surprise to the Attorney General's office. Mr. DeLucia wondered whether Attorney General's office could be seen as anti-environment for not advocating for coal technology. Ms. Matthews responded that the Attorney General's office was split in their support for (and against) the legislation. Furthermore, the Attorney General and the governor did not agree on the issue, primarily because the Attorney General's office in

Kentucky has less of an environmental role than a very conservative consumer advocate rule.

Ms. Matthews introduced other mechanisms for coal technology advancement. Additional options that have been discussed in Kentucky are developing public/private partnerships and allowing a consortium of utilities to share one facility. PolyGen facilities combine multiple outlets, including electricity. These facilities sell ancillary products to offset the price of electricity generation. In addition, PolyGen facilities have multifaceted benefits, including a flexible product mix, economic development through job creation, reduced emissions, and opportunities for synergies with bio-diesel and ethanol production.

Investment in a new technology like PolyGen facilities can be a risky undertaking. Ms. Matthews explained that this is not your grandfather's power plant; different skills, increased capital costs, and a new business model are necessary for success. Power plants tend to be run in a process-oriented and methodical manner, which poses problems when considering the high start up costs versus uncertain benefits. Furthermore, the new technology presents many regulatory challenges for state PUCs and PSCs.

Ms. Matthews ended her presentation by emphasizing that Kentucky would like to maintain its relatively low rates while preparing itself for an increase in electricity demand in the near future. When considering coal as a power alternative, the state must make sure these technologies are "clean" and cost-effective.

Daniel Cunningham, Public Services Enterprise Group (PSEG), asked whether there are advanced oil recovery efforts in Kentucky. Ms. Matthews responded that there is some research and development money in the pipe for advanced oil recovery. The state is looking at the Illinois basin and a little-known eastern Kentucky oil field as possible sites for this type of technology.

Marty Smith, Xcel Energy asked whether cost to coal technologies has a time dimension to it. As he sees it, two factors will impact energy costs in the near future. First, carbon dioxide emissions could be constrained, a change which will require retrofit costs. Some states have anticipated this change by implementing an adder policy; this, however, is not in Kentucky's regulatory framework. Ms. Matthews confirmed that this kind of policy is not being pursued in her state.

Secondly, Mr. Smith equated a pulverized coal plant to the internal combustion engine; it will evolve as far as it is pushed. Success is dependant on forward-thinking leaders in the field who will be willing to make the initial investment for an opportunity for lower costs fifteen years from now. Mr. Smith asked whether Kentucky wanted to be a "leader" or a "taker" in this field. Ms. Matthews commented that everyone wants to be the second IGCC plant! Rather than invest their time and resources in a risky venture, most companies (and states) would rather wait for someone else to take on that risk.

Mr. Smith's last question involved the 35% increase in electricity costs for the residents of Kentucky. He asked whether the increase would be across the whole state, or for one service area. Ms. Matthews confirmed the 35% increase would be the result of adding one 600 MW plant. The cost increase would only be this large if the cost of this plant was spread over a very tiny sliver of Kentucky power customers. The law did, however, promote this technology without penalizing a very small sub-set of customers.

Eugene Trisko, Attorney at Law, asked whether Kentucky could use the passing of the North Carolina Clean Smokestacks Act as a case study for trying to pass advanced coal technology legislation in Kentucky. This legislation was significant, but it was proposed by a broad array of people focused on incremental costs across the whole state. Ms. Matthews agreed that the North Carolina law is a good case study, but noted that a rare "perfect storm" came together in favor of that particular legislation.

Financial Community's Perspective on Advanced Coal Technology and CCS

The session began with an introduction of new members that were not introduced the previous day: Sara Glenn, Shell Oil Company, and Paul Bollinger, U.S. Air Force.

The introduction of new members was followed by a presentation by Jeff Miller, The Tremont Group, LLC. He began his presentation with an overview of his company and his work experience. The Tremont Group is a private equity firm that focuses on the energy industry. Mr. Miller's previous work experience includes working for Goldman, Sachs & Co. where he ran the power-generation segment in the 1980s. Mr. Miller is on the board of the World Resources Institute and he has worked with the Gas Technology Institute. Through his experiences, Mr. Miller has become familiar with investments in coal fired plants, gas fire, and alternative energy. Additionally, he is familiar with advanced technology and various types of advanced energy generation including fuel cells.

Mr. Miller next gave an overview of advanced coal technology. He said the resurgence of coal-fired generation is a dramatic change. For example, his company made an investment in a coal company in 1996 despite being advised against it from an economic and policy perspective. However, this investment went 24:1 over the last 10 years showing that there has been an abrupt change in the perception of the economics of coal. As a result, there has been a substantial new investment in coal plants and development of competing technologies.

Mr. Miller continued by saying that the perspective of an investor is forward-looking, anticipatory, and non-ideological. It is necessary to not only get the investment right, but also to get the timing right.

Mr. Miller next explained that coal is abundant and cheap. The price gap between coal and natural gas is wide enough to cover efficiency and environmental costs, and it is by this thesis that his company made their investment in the coal company. An added feature of the investment thesis is that coal plants have security values; they are not

unstable places. Lastly, Mr. Miller noted that coal-fired generation has played a major role in electricity production and will continue to do so in the future, both in the United States and globally. He used China and India as examples.

Mr. Miller followed his investment thesis explanation with a discussion on investor needs. He said investors need regulatory clarity and predictability; however, this is absent today and is not on the horizon. There also needs to be transparency (e.g., where do the costs come from? where do the prices come from? and how are they determined?). In order to get investment in scale, there needs to be a focus on market mechanisms that will drive the capital. There also needs to be a limitation of liability in terms of being able to probe depth and being able to understand dimension.

In explaining investor issues, Mr. Miller said one issue is that the merchant market is currently chaotic and there is not a fully-functioning U.S. carbon market. Another issue is that while pulverized coal (PC), which is a powder like substance, is well-established, integrated gasification combined cycle (IGCC) is not. Mr. Miller compared IGCC to a chemistry set; it is a process industry, which is a departure from the utility industry. Lastly, Mr. Miller mentioned the investor issue of the difficulty in maintaining technology performance guarantees.

Judi Greenwald, Pew Center on Global Climate Change, asked about giving wraps. Mr. Miller replied that getting a wrap is one thing, getting a wrap that is economic is another, and getting a wrap that has teeth is another. The issue is getting efficiency guarantees. It is necessary to rely on specific warranties of subcomponents. Therefore, integration is the major issue.

Mr. Miller finished his discussion on investor issues with emerging carbon capture technology. The main questions about this topic are: what is it? is there such a thing? what will it cost? and how do you anticipate the impact?

Mr. Miller next presented a supply and demand curve showing the point of capital cost recovery. This point is where the market clears so that the price not only covers production costs, but also gives a return on capital. If the price drops because of a shift in the supply curve, variable prices will continue to be recovered, but capital still cannot be recovered. The flip side is if capacity is too tight and the demand curve shifts resulting in price spikes. The main point, Mr. Miller said, is that there currently is no reliable way of predicting the long run marginal cost of capacity in the U.S. market.

Mr. Miller followed the supply/demand curve with a visual representation of investment parameters and how these lead to technology choices. There are four interacting markets: fuel, electricity, SO_x/NO_x, and carbon (does not currently exist, but there are shadow prices). Mr. Miller said it was necessary to first develop a market conviction, regionally as well as nationally, and next it is essential to pick technology (i.e., PC or IGCC).

Mr. Miller next discussed five investment considerations. The first, rate base treatment, has raised a lot of discussion, particularly when there are externalities and societal costs

and benefits. Second, the stranded cost risk is significant from an investment perspective. There was a cycle of this during deregulation and it was a big issue. Third, accounting treatment is an arcane and subtle, yet profound issue. Because of Sarbanes Oxley and the issue of stranded cost, the accountants are driving the search for potential stranded investments. Therefore, when making an investment in a power plant, it is necessary to not only be concerned with rate of return, but also the appropriate depreciable life of the plant from an accounting perspective. As for carbon, Mr. Miller said it is important to ask if there is a necessity of having a shorter life than the traditional forty year period. Finally, investors need to consider flexibility and optionality (i.e., making bad bets and if bad bets are made, can they be made good).

Mr. Miller continued with a discussion on running investment analytics. Traditional analytics are net present value (NPV) and internal rate of return (IRR), which is a more static analysis. Because of the need for probability weight analysis, decision trees and Monte Carlo simulation have developed as the way people are looking at these investments. The final approach is a more dynamic and probabilistic approach using option pricing. Real options analysis is being used to develop multiple distributions in multiple markets and look at under what circumstances investment turns good or bad. This analysis breaks the investment into multiple investments over time. This approach has a bias for smaller more modular investments. Mr. Miller said the corollary of this is that there are a lot of private equity investors that are focused on energy.

Lastly, Mr. Miller reviewed potential flawed assumptions. First, he said IGCC may not be cheap and easy to retrofit CCS because the rebuild of the gasifier is almost as expensive as the initial investment. Also, enhanced oil recovery (EOR) may not be a good use for carbon sequestration; however, it may be good for testing carbon sequestration.

Mr. Miller next discussed a recent, unpublished study about energy demands and CO₂ emissions and answered some questions about the study.

After discussing the study, Mr. Miller provided some of his personal opinions and stated that none of the opinions he shared reflected any of the organizations that he is affiliated with. In comparing a market based approach versus a command and control approach and carbon tax versus cap and trade, Mr. Miller is biased toward a market based approach and a cap and trade system. Cap and trade creates price discovery and price transparency and this has been seen, for example, in the Clean Air Act trading that was done with carbon and NO_x. Hedge funds, private equity firms, and investment bankers are positioned to deploy and commit a lot of capital based on a global system resulting in price transparency and price discovery. If done on a political basis without price transparency, much of the impact will not be there.

Greg Schaefer, Arch Coal, Inc., questioned whether cap and trade and carbon tax were the same thing in terms of the political decision. He asked why one felt more comfortable to Mr. Miller as an investor. Mr. Miller responded that, yes, the ultimate supply/demand balance and the ultimate cap are political decisions, but cap and trade is a

more transparent process. Mr. Miller said that the European Union passed out too many emissions allowances and the price collapsed. There is often concern that there is a loss of control in a market based system; however, this is not true because it can ultimately be controlled by the constraints.

Ms. Greenwald asked about incentives that the work group could recommend that would make a difference to Mr. Miller's discussions. Mr. Miller responded that a dialogue focusing on the issues discussed and also looking at economics is essential. He also suggested market based approaches which are important to investors for the reasons embedded in his presentation. It is important, he said, not to pick a single technology as a winner, not to focus on the answer, and not to make a simply policy decision. There is a lot of technology and the market responds well to a price signal and eventually the technology will follow the prices.

Paul Bollinger, Air Force, said in a survey that was done by the Defense Logistics Agency, energy companies were asked what it would take for them to produce 200 million gallons of fuel in the future. Aside from the various tax incentives, they said long term off-take agreements were their first priority. Mr. Bollinger asked how Mr. Miller would view a long term off-take agreement as being sufficient to protect the interests of the buyer (i.e., government). Mr. Miller responded that when doing project financing and the credit is the project itself, the use of a long term off-take contract is one of the critical tools for establishing financial feasibility. A long term contract from a credit worthy counterparty is the basic building block. This is something that can make any project work. The question is: what are the objectives and risks you are willing to take? Other devices are to establish a minimum return or to create a floor price. In the end, Mr. Miller said you need to look at a risk premium or take the risk out and require less equity and get a cheaper price. A government contract over a long term period is a way to get projects done at scale.

David Foerter, Institute of Clean Air Companies (ICAC), asked if Mr. Miller saw the disconnect of how Wall St. is looking at these investments versus the way public service commissions are looking at investments as leading to different conclusions or similar conclusions. Mr. Miller said the rate commissions are set up to focus on a reasonable return on invested capital. The basic metrics that every commission in the country deals with is what is the useful life and fair return on the invested capital. It is the commissions that are on the line in dealing with a lot of these questions and that are making investments and going to the state for permits. Mr. Miller said there are many legal constraints that the commissions are working under. Mr. Foerter said he was wondering if commissions may in the future be stuck with an investment made today with few options because the constraints of law or the framework in which they are looking did not allow them to value that down the road. Mr. Miller said this was seen before with the deregulation of gas and the pipeline investment, and deregulation of the electricity industry. The question is what the bargain is going in; it is not an analytical question, but a political question.

Eugene Trisko, Attorney at Law, said in terms of the assessed risks, there is a debate today about the allocation of allowances. He asked if there was reason to believe from the perspective of the financial community that the use of a pure auction device would add materially to the risk of coal-based projects. Mr. Miller responded that it could; it depends on how the exchange is set up, how the rules are set, and how certification is done. The set up of the trade is critical and international scale aspects are particularly sensitive.

Bruce Rising, Siemens Power Generation, asked if with global development, there was a competition for capital. Mr. Miller responded, directionally, yes. It is complicated, but in short, capital will flow.

Work Group Members Identify Additional Information, Sources of Information and Topics for Future Work Group Meetings

Ben Henneke, Clean Air Action Corporation, thanked the work group members for the presentations. He also thanked Anna Marie Wood, EPA, for compiling the agenda and mentioned that the remainder of the afternoon would be dedicated to addressing the work group's questions. He noted that the work group will work hard together through the next few months until a draft report is completed.

Pat Tallarico, SRA International, and Laura Bachle, EPA, gave an overview of the agenda and explained their roles as facilitators. The work group was instructed to meet in small groups to discuss any additional topics that they wanted additional information on and to come up with any remaining topics that should be considered for further exploration. The small groups were instructed to prepare a report-out of their recommendations.

A work group member asked for more clarity on the difference between remaining information and remaining topics. Anna Marie Wood explained that remaining information relates to information that still remains on advanced coal technology (ACT) where the informational aspect needs more discussion for a better understanding of ACT. The remaining issues however are what additional issues the work group wants to talk about.

Judi Greenwald, Pew Center on Global Climate Change, asked for a two minute version of the scope that should be covered since there seemed to be a lot of information that could be covered. She asked for the question to be framed a bit tighter.

Mr. Henneke responded that the work group charge was about the group's identity. He clarified that the workgroup was convened by EPA according to the Clean Air Act Advisory Committee's recommendation. The group's work could be limited, in the sense of just sending a report to EPA; but he added that EPA does not have all of the tools necessary to make the work group successful. Mr. Henneke continued that he and Robert Brenner, EPA, want the group to come up with the best steps toward recommendations that may go outside of the scope of the report to EPA.

Ms. Greenwald clarified that she still wanted more information on the scope of the discussion for the small-group work. Mr. Henneke responded by reading the work group charge, mentioning specifically that the scope should cover the “potential barriers and potential opportunities to create incentives under the Clean Air Act to the development and deployment of advanced coal technologies.” He said that since there are people in the work groups who will be able to speak in other forums, there should be consensus on recommendations so that a message can be deployed on a national and global scope.

Lisa Gomez, Sempra Energy, suggested that the group talk about the charge since it will dictate the next set of discussions. She added that if the group could agree on the charge, the subsequent discussions would be more focused. Mr. Henneke asked Ms. Gomez how she would change the charge. Ms. Gomez said that from the very beginning, Carolyn Green, Sunoco, had suggested considering IGCC with petroleum coke and IGCC with coal to go beyond what is already included in the charge.

Mr. Henneke responded that he thought this information was included the charge since coal includes all solid fuels. Ms. Gomez added that one section of the charge is “to create incentives under the Clean Air Act.” She asked if the workgroup wanted incentives to go beyond the Clean Air Act, for example, at the state level. She said that if the answer is yes, it would change the scope of the charge. Mr. Henneke agreed that state and local levels should be included in the scope, but it must be recognized that the official product is going to go through a certain chain of command.

Mr. Brenner replied that EPA was fortunate to have a group of people with so much expertise and so many entities represented on the work group that were critical for the advancement of coal technologies. He noted that the only way for the group’s recommendations to make sense is if the group has a shared perspective of the whole set of activities that can move the group forward towards advanced coal technology development. He added that there are a certain set of actions that the coal companies, power generators, EPA, environmental groups, and NGO’s can take in which the whole would be greater than the sum of the parts. He said that the work group could get the most done in a quick manner with a shared vision in place. He suggested that the work group share some thoughts on expectations and that the focus could be narrowed as the process continues. For the time being, the group should take a “big picture” perspective, even though there is a risk to be too immersed in information.

Ms. Woods agreed and gave an example of a request for information and topics that came up in her small group. She said that her small group discussed how action needed to be taken on public education and outreach regarding carbon capture and sequestration. She added that her small group also discussed how the integrated efforts of state and federal incentives could better facilitate the deployment of technology.

Mr. Henneke responded that EPA chose to convene the work group that now faces a decision as to what it wants to accomplish to make a difference in the deployment of advanced coal technology.

David Berg, Department of Energy (DOE), suggested adding “financial” in the second paragraph of the charge regarding the discussion of various types of information. Mr. Henneke agreed, but said that if the group began to rewrite the charge, it would become 15 pages long. He added that the development and deployment of advanced coal technologies must be financed, so finances are already included in the thinking.

Mr. Brenner said that the group should flag any concerns they have about the charge to be readdressed another time and added that it would be time-consuming to redraft the charge. He said that the group can still look at issues, but that he intended for the charge to be interpreted pretty broadly, so there should not be any reason for a re-writing process. Mr. Henneke added that the six month report needed to be completed in a timely manner.

Tony DeLucia, East Tennessee State University, asked if coal to liquids could be included in the first paragraph. He wanted to know if any one objected. John Campbell, Caterpillar Inc., replied that the scope might be too large if other applications such as coal to gas and mobile applications were included. Mr. Brenner said that there was not a reason to wrestle the issue of coal to liquids to the ground, but that some of it can be addressed.

Alvaro Linero, Florida Department of Environmental Protection, asked if the charge referred to the Clean Air Act as presently written as well as any of its successors. Mr. Brenner responded that the understanding was that the focus was on the Clean Air Act as written, but that if the group wanted to identify suggested changes it could. Mr. Tallarico added that Mr. Linero’s question brought up the issue of barriers and obstacles.

Mr. Tallarico suggested that the small groups should talk more about the charge. Ms. Bachle reminded the small groups to choose a reporter to present their recommendations to the entire work group.

The small groups spent 20 minutes discussing the topics amongst themselves. When the group reconvened, Mr. Tallarico asked each small group to begin sharing their topics and recommendations. Below is a list of information requests and questions asked or reported by the small groups:

- More information on storage and information on the range for the capture percentages in order to see the possibilities for lower costs.
- More information on sequestration issues.
- A presentation on what CAAAC does in terms of the Clean Air Act as it applies to advanced coal.
- More from the utilities perspective, including proponents and opponents of ACT.
- More about the regulated and deregulated electricity structure in the U.S. and how it relates to the advance of new generating technologies.

- More on the lessons learned from the past IGCC pilot projects or gasification projects, including issues like development, funding, permitting, technology, economics, etc.
- More information on accelerated permitting around the country, including a website with a comprehensive review of renewables/incentives, etc.
- A better understanding of the opportunities for tribes to work with states.
- More information on the definition of “advanced coal.”
- A discussion of the benefits side of the equation that will discuss more of the costs.
- More information on fuel access issues and how they affect the siting of generation and distribution facilities .
- A discussion of how to incorporate a domestic policy into a global issue.
- Exploration of ocean seeding.
- Background information on the relevant federal programs and funding that could potentially advance technology; this information will give work group members a sense of to whom they could make recommendations and about what issues.
- More information on PolyGen or Energy Farms and the technology and costs associated with the projects.
- More information from technology project developers who is actually developing the plants so that we can get more information on the barriers they see (not limited to utilities or United States).
- Regulatory clarity (including permitting issues) related to where carbon prices comes from, the certainty of the market, the value of the carbon that is captured, and how you determine credit generation. For example, how do you determine if you get any credit generation, and if so, how much do you get? The group added that it would be helpful if there was a protocol for determination of credits, as there is in Canada.
- A discussion on whether a command and control enforcing technology regulation is a better way to bring about these advanced coal technologies.
- Lessons learned on what other countries have accomplished in the ACT field. This global perspective will be a guide of other strategies that we can adopt.
- A “Clean Air Act 101” presentation by relevant authorities, including a broader list of the relevant federal statutes (i.e. Clean Water Act) to create synergies between different authorities to advance coal technology.
- Information on current regulations that affect sequestration.
- Does sequestration fall under covered utility activities?
- What are the retrofit costs for CCS?
- Presentations on the status of pre-commercial technologies and other capture technologies.
- Information on oxy-fuel combustion.
- Presentation of briefings on business case studies.
- Request for the document on permitting guidelines for IGCC done by EPRI. [Note: Steve Jenkins, URS Corporation, said the document is confidential, but he could provide a briefing)

- How many new plants need to be constructed in the next 20 years to meet our energy needs?
- How do we deal with the transmission issue?
- More information on other environmental impacts of advanced coal technology, such as water quality and waste.
- An interest in knowing more broadly what is happening on the climate policy front. This will provide a context for the work group.
- Information on EPA's environmental direction and whether there is a vision towards zero emissions.
- Information on issues beyond sequestration.
- What in the footprint document we have from before needs to be updated?
- Is there a place where all of the permits that have been applied for or issued for IGCC projects are compiled? [Mr. Jenkins says it is in the report mentioned earlier and he can share it.)

After the group finished their recommendations, Mr. Henneke suggested it was time for a break. Mr. Tallarico agreed and noted that there was one public comment on not having public utility represented.

The group took a break and when the group reconvened, Mr. Tallarico said that the groups still needed to talk about issues to make sure that there were no other topics that the group wanted to consider. The small groups met for 5 minutes to talk about remaining issues. Below is a list of topics, issues, and questions that remained:

- What is the definition of advanced coal technologies (ACT)? Are we looking at all emissions, or just carbon emissions?
- We need a shared understanding of ACT, and how to prioritize everything we have come up with.
- How do we limit the scope of this project? Prioritization is necessary.
- A request for a presentation on permitting issues related to air quality and NEPA.
- Information on water issues and how they affect technology issues.
- What is a consensus?
- How do we engage other relevant federal agencies in our process?
- How to get more technical expertise on ACT at EPA and state agencies.
- Do we need representation from the PUCs on the work group?
- What is the scope of the incentives in our workgroup charge? How far can we go in this process?
- With "phantom projects" clogging up the system, how do you use the scarce resources we have to engage the projects moving forward?
- More information on PolyGen.

At the conclusion of the report-outs, Mr. Tallarico explained that the co-chairs would review the recommendations and requests for information to prioritize the list. The basic definitions and foundations would be prioritized, followed by presentations from within the group. Mr. Tallarico continued by explaining that for the additional questions, the

information would be grouped and categorized. These requests will drive the agenda for future discussions.

Work Group Members Discuss Expectations and Outcomes for Work Group Process

Laura Bachle, EPA, asked if small groups would continue to work as the work group moved forward. Anna Marie Wood, EPA, responded that the work group does not need to decide right away if small groups are necessary. She added that once the information has been categorized, it may make sense to work in smaller groups in a more focused way.

Ben Henneke, Clean Air Action Corporation, added that some topics, such as Clean Air Act 101 or permitting, may be important for half of the group, but not for the rest. He suggested that some issues could be scheduled as conference calls for smaller groups with report-outs back to the larger work group. Without this, he said that the list may be unmanageable. Judi Greenwald, Pew Center on Global Climate Change, added that the group needed to soon decide to not follow up on some of the additional topics.

Maha Mahasenan, Rio Tinto Energy America, said that the small groups may sound like a good idea, but pointed out that there would need to be adequate representation on each of the subgroups. Without this representation, the inherent biases in the groups would pose a real challenge. Mr. Tallarico responded that the conversation may be difficult to have because the scope of things to talk about is so large.

Sara Glen, Shell Oil Company, suggested that Ms. Wood develop a work plan and move forward on the issues. A workgroup member responded that he thought it was premature to develop a work plan at that point. Chris Hobson, Southern Company, said that the group needed to develop a work plan based on the charge. He added that the group was not charged with choosing technologies, but charged with development and deployment of ACT. Larry Myer, Lawrence Berkley National Lab, said that the group should soon have a list of ideas about what barriers and opportunities exist, since that is part of the charge.

Public Comments

Pat Tallarico, SRA International, announced that one public comment had been submitted that suggested public utilities should be represented on the work group. No other comments were submitted.

Discussion of Future Work Group Meeting Logistics and Schedule, Wrap-up and Adjournment

Pat Tallarico, SRA International, agreed that these are all good suggestions. He noted that the last issues to cover were the draft charter and schedules. The proposed schedule for

upcoming meetings is once a month for the next 12 months. Mr. Tallarico explained that the meetings could begin on a Monday afternoon and go through Tuesday midday (to allow West Coast members to get in on time), or they could take place just one day. He added that the meetings could also be held in other locations, such as Phoenix or Los Angeles.

Lisa Gomez, Sempra Energy, responded that she thought a one day meeting would be ideal for West Coast members and added that she would like to see meetings held on the West Coast. The work group members agreed to do a one day meeting and many members expressed an interest in holding the meetings at locations other than Washington D.C. Some members expressed that there was a conflict in February and April.

Anna Marie Wood, EPA, asked the group to lock in February 8 and March 6 from 8:30am-5:00pm. She added that anyone with conflicts should email her.

John Campbell, Caterpillar Inc., asked if any of the meetings can be done by phone. Mr. Tallarico responded that this issue would be discussed shortly. First he mentioned the draft charter, which the work group members received the day before. He asked if there were any concerns on the charter.

William Auberle, Northern Arizona University, said that if the work group was fast tracking towards consensus, alternates would be problematic for the process. He added that if any member could not attend, they should participate via phone instead of an alternate. Judi Greenwald, Pew Center on Global Climate Change, asked if the question could be deferred until the group decided what consensus meant. Mr. Tallarico agreed and continued to ask if there were any questions on the charter, particularly related to the technical experts section.

Tony DeLucia, East Tennessee State University, asked about the decision process for bringing in technical experts. Mr. Tallarico responded that the language was left open in order to bring in experts from anywhere. Rick Bolton, Center for Toxicology & Environmental Health, mentioned that the Kingsport facility welcomed the work group to visit their facility if any one was interested. Laura Bachle, EPA, suggested using experts in the work group as presenters. She added that anyone interested in presenting a topic to the group should email Ms. Wood and Mr. Henneke.

Mr. Tallarico asked if there were any questions regarding the expectations for participation in the charter. The draft charter included a section that did not permit work group member participation by phone. Mr. Tallarico explained that it can be very challenging to have a group discussion that is interactive if anyone is on the phone. Mr. Auberele responded that he thought people should be able to call in as long as they were designated listeners only. David Foerter, Institute of Clean Air Companies, said that the call-in situation did not seem reasonable anyways since no one would want to be on the phone for 8-9 hours.

Ben Henneke, Clean Air Action Corporation, suggested excluding alternates if in exchange the group agreed to brief the members that could not attend. Ms. Wood responded that she was reluctant to go in that direction and added that there will be meeting summaries for each meeting. Sandra Ely, New Mexico Environment Department, added that it would be tough to reach momentum if the work group lost any members. She added that if members do not make meetings, the work group should commit to not readdressing issues that were already discussed.

Mr. Campbell said that he wanted to be able to participate and be inclusive by sending an alternate and still call in when he is unavailable to travel to the meetings. A work group member responded that everyone has other things to do and the fact that people show up is a personal and organizational commitment. He said he was insulted by the last page of the guidelines for communications. He added that it should respect that everyone in attendance is willing to put in the personal and organizational commitment. He noted that perhaps we should have guidelines for the management. For example, perhaps there should be a requirement that if the agenda lists a decision that will be made, members will know that they can send in a proxy if they will be unable to attend.

Mr. Henneke responded that he liked the idea of some expectations for what the co-chairs owe the group. He said that he thought that in three months, the co-chairs would be more behind the scenes. A work group member questioned the clause. Mr. Henneke responded that he thought that the clause meant that if you do not show up for eleven meetings, you cannot have a say in the end that is documented.

Mr. Tallarico summarized the group's requests to simplify the expectations for the participants and to clarify the section participation. He said they would add a section on trying to be at the meetings, but allowing for an alternate if necessary. He added that they would try to set up a phone for the meetings.

Mr. Hobson said that if he sent an alternate, he would make a commitment that the alternate would not backtrack. Mr. Campbell added that he did not mind if phone-in members were listeners only.

Ms. Greenwald brought up the issue of consensus and its definition. Mr. Tallarico said that consensus meant that members should speak up if they cannot live with the decision. He added that consensus is not necessarily by majority, but instead based on whether or not everyone can live with it and no one necessarily disagrees with the recommendations.

Ms. Gomez added that she was concerned about the notion of consensus meaning that no one disagrees because it would likely lead to the lowest common denominator. She suggested instead a substantial consensus, which would allow for more edgy recommendations. Mr. Tallarico responded that if the group operates with substantial agreement, where most of the group agrees, what would be the number necessary for agreement? Ms. Gomez replied that there is no real number, just almost everyone.

Mr. Brenner expressed support for Ms. Gomez's recommendation and added that using substantial consensus would allow the group to bring a lot of ideas to the table.

Mr. Tallarico noted that the charter would be revised to include substantial consensus and some language would be added to explain what a person should do if they missed a meetings. He asked if there were any questions on the guidelines for communication.

Ms. Wood said that the point about phone-in callers being on a listen only basis may be useful.

Ms. Greenwald said that given the new definition of consensus, she expressed support for the use of alternates. She noted though that she was sympathetic to the point about having a continuous conversation, so there should be a clause about alternate responsibilities in the charter. Mr. Tallarico responded that he would revise the charter and return it to the group.

Mr. Henneke said that under FACA, you get your name listed on the website, which has increased the amount of junk mail he has received. He recommended limiting emails to just the work group members and not posting addresses on the web. He also asked EPA to not make the emails public. Ms. Wood responded that they were thinking of posting a work group member list with presentations, agenda, meeting dates, etc on the website, but wanted to make sure that people were comfortable with that. She asked if any one had any concerns.

Mr. Campbell asked how soon the presentations would be available. Ms. Wood responded that she would have to check, but she thought they would be available by Friday.

Mr. Henneke said that the last thing on the agenda was to talk about the facilitator's in a plus delta exercise, which would assess the things that were beneficial about the facilitators and the things that the group wanted to see changed. The work group summarized that the benefits of the facilitators were as follows: they freed up the co-chairs to listen, they brought an ability to prioritize, they kept the group on schedule to finish the agenda, and they were organized and easy to communicate with. As for changes, the work group suggested that they could have moved more quickly towards barriers and opportunities. The co-chairs responded that this item would be on next month's agenda.

Ms. Wood thanked the work group for attending and the meeting was adjourned.

**Clean Air Act Advisory Committee
Advanced Coal Technology Work Group
January 8-9, 2007
Double Tree Hotel (Crystal City)
Arlington, VA**

List of Attendees

Name	Affiliation
Nick Hutson	EPA/ORD (RTP, NC)
Larry Boggs	General Electric (GE)
Marty Smith	Xcel Energy
Mike Sewell	EPA/AQPD (RTP, NC)
Todd Johnston	National Mining Association
Alvaro Linero	Florida Department of Environmental Protection
David Berg	U.S. Department of Energy
Rick Bolton	Center for Toxicology & Environmental Health, L.L.C.
Barbara Bankoff	Bankoff Associates (for Siemens)
Frank Blake	American Electric Power (AEP)
John Kinsman	Edison Electric Institute
Karen Obenshain	Edison Electric Institute
Carolyn Slaughter	Institute of Clean Air Companies
Guido B. DeHoratiis	U.S. Department of Energy
Jeffrey W. Hopkins	Rio Tinto
Joe Miakisz	MJ Bradley & Associates
Ned Leonard	Center for Energy and Economic Development (CEED)
Ravi Srivastava	EPA/OAQPS
David C. Foerter	Institute of Clean Air Companies (ICAC)
Anna Marie Wood	U.S. EPA
Ben Henneke	Clean Air Action Corporation
Sandra Ely	New Mexico Environment Department
David Berg	U.S. Department of Energy
John McManus	American Electric Power (AEP)
Lisa Gomez	Sempra Energy
N. "Maha" Mahasenan	Rio Tinto Energy America
Daniel Cunningham	PSEG Services Corporation
Patrice Simms	National Resources Defense Council
Eric Svenson	Public Service Enterprise Group (PSEG)
Rob Brenner	U.S. EPA
Judi Greenwald	Pew Center on Global Climate Change
William Auberle	Northern Arizona University
Robert Wyman	Latham & Watkins
John Campbell	Caterpillar Inc.
Sara B. Glen	Shell Oil Company

Name	Affiliation
Paul Bollinger	Air Force
Steve Jenkins	URS Corporation
Daniel Chartier	U.S. EPA
John Thompson	Clean Air Task Force
Lisa Stolzenhaler	GE Energy
Mark MacLeod	Environmental Defense
Anthony DeLucia	East Tennessee State University
Chris Hobson	Southern Company
Robert Hilton	ECS Global ALSTOM Power, Inc.
Christopher Romaine	Illinois Environmental Protection Agency
Anhar Karimjee	U.S. EPA (Climate Change Division)
Simon Mui	EPA Office of Transportation and Air Quality Transportation and Climate Division
Michael Ling	U.S. EPA/OAQPS
Bob Gruenig	National Tribal Environmental Council
Greg Schaefer	Arch Coal, Inc.
Bruce Rising	Siemens Power Generation
Eugene Trisko	Attorney at Law
Robert J. Wayland	U.S. EPA
John Thompson	Clean Air Task Force
Larry Myer (alternate for Sally Benson)	Lawrence Berkeley National Lab
Laura Bachle (facilitator)	U.S. EPA
Pat Tallarico (facilitator)	SRA International
Jeff Miller (presenter)	The Tremont Group, LLC
Kate Burke (presenter)	National Conference of State Legislatures (NCSL)
John Novak (presenter)	Electric Power Research Institute (EPRI)
Talina Matthews (presenter)	Kentucky Office of Energy Policy (OEP)
Stu Dalton (presenter)	Electric Power Research Institute (EPRI)
Julio Friedmann (presenter)	Lawrence Livermore National Laboratory