

## **Executive Summary**

The Coal Systems Analysis & Planning Division (CSAPD) supports the strategic planning and technology assessment necessary to craft a comprehensive and balanced portfolio of research and development activities to address all aspects of producing clean energy from coal. The Division provides technical data and analytical tools for sound, rational coal and power systems related policy development, including environmental and regulatory issues, economic and market trends, program performance metrics, and benefits analysis.

Consistent with NETL's performance metrics, coal systems analysis projects will be subjected to periodic merit reviews. This review was the first conducted for CSAPD projects. Merit reviews serve to evaluate the performance of ongoing work to determine the effectiveness and adequacy of the projects. The merit reviews also provide a means of guiding future activities to ensure intended objectives are met. Projects are reviewed by a team of technical experts from industry, academia, outside research laboratories including the national laboratories, and the relevant NETL personnel.

Twelve Systems Analysis projects were reviewed on August 10-11, 2005 at NETL's Pittsburgh facility. NETL Leads (Leads) presented project work scopes, progress made, and planned work.

Four projects received an overall rating of "Outstanding," with numerical averages of 3.50 or better. Seven of the twelve projects received an overall rating of "Good," with numerical averages between 2.50 and 3.50. One project received an overall rating of "Satisfactory," with a numerical average between 1.50 and 2.49.

The project receiving the highest overall score was B5. Evaluating Novel Gasification Concepts. This was closely followed by C1. Sequestration Sorbents.

The following sections of this document provide a summary of the merit review process and individual summary assessments of each of the twelve projects reviewed.

## Merit Review Process

The FY 2005 Systems Analysis merit review was held at NETL's facility in Pittsburgh, Pennsylvania on August 10-11, 2005.

The review team consisted of the following:

- Francis Lau – Gas Technology Institute;
- Bob Hirsch – Science Applications International Corporation;
- John Wootten – Peabody Energy, Inc.;
- Ron Wolk – Private consultant; and
- Sam Biondo – DOE FE Headquarters.

Following opening remarks by Jim Ekmann and Michael Eastman, twelve (12) projects were presented by the Leads. These projects are as follows:

- A1. FutureGen: Multiple Selected Case Studies – John Wimer;
- B1. Pollution Control Impact Study – Michael Reed;
- B2a. Market-based Advanced Power Systems: Study – Julianne Klara;
- B2b. Market-based Advanced Power Systems: Tools Development – Michael Reed;
- B3. Gasification Alternatives: Select Applications – Jeff Hoffmann;
- B4. Gasification R&D Technical Pathways – Julianne Klara;
- B5. Evaluating Novel Gasification Concepts – Julianne Klara;
- C1. Sequestration Sorbents – Jared Ciferno;
- C2. Sequestration Membranes – Jared Ciferno;
- C3. Sequestration Solvents – Julianne Klara;
- D1. PC Oxyfuel System Evaluation – Jared Ciferno; and
- D2. Alternate Approaches for Hydrogen Economy – Pete Balash.

Reviewers were asked to rate and comment on each project in six areas: goals and objectives, identification of key technical challenges, soundness of approach, demonstration of effectiveness and results, future direction, and project overall (Exhibit 1). Based on the reviewers' rating of the project overall, an average overall score was derived. The following rating scale was used to evaluate each of the criteria:

- Outstanding (4 points) – **entirely** follows industry best practices; **always** exceeds reasonable expectations; results are **highly** credible compared to most;
- Good (3 points) – **mostly** follows industry best practices; **almost always** meets reasonable expectations; results are **as** credible as most;
- Satisfactory (2 points) – **usually** follows industry best practices; **typically** meets reasonable expectations; results are **somewhat** credible but need more validation;
- Marginal (1 point) – **occasionally** follows industry best practices; **sometimes** meets reasonable expectations; results are **less** credible than most; and
- Poor (0 points) – **seldom (rarely)** follows industry best practices; **does not** meet reasonable expectations; results are **not** credible.

<b>Exhibit 1 – Project Evaluation Criteria</b>
<p><b>Goals &amp; Objectives</b></p> <ul style="list-style-type: none"> <li>To what extent does this analysis support program objectives and assist in guiding the direction of R&amp;D?</li> <li>Is the issue being addressed by the analysis clearly defined?</li> </ul>
<p><b>Key Challenges</b></p> <ul style="list-style-type: none"> <li>To what extent have the appropriate technical, environmental, economic, regulatory, and policy issues and barriers in this area of analysis been identified and addressed?</li> </ul>
<p><b>Approach</b></p> <ul style="list-style-type: none"> <li>How would you describe the NETL Lead’s command of the relevant literature and analysis techniques?</li> <li>How coherent is the approach? To what extent does it build on previous research and analysis efforts and complement on-going efforts?</li> <li>To what extent is the analytical framework and level of detail appropriate to conduct credible analyses?</li> <li>Is the method transparent and are assumptions articulated so that others can review and compare results?</li> <li>Are the technical, economic, and performance assumptions appropriate?</li> <li>Are technical and economic results compared in an appropriate and unbiased manner?</li> <li>How effective is the NETL Lead’s communication and collaboration with others in the field, including in-house and contracted research for NETL?</li> <li>Is the proposed effort duplicative or does it complement/supplement other work being conducted in this area, or is it unique?</li> <li>Has the NETL Lead planned for adequate resources (human, analytical tools, etc.) to conduct the effort as proposed? Are the resources adequate and appropriate?</li> <li>Comment on the coordination between modeling and experimental work in the field, and in particular, at NETL.</li> </ul>
<p><b>Effectiveness &amp; Results</b></p> <ul style="list-style-type: none"> <li>Do the analysis results adequately address the critical issue(s)?</li> <li>Was adequate technical progress made based on the technical challenges and resources allocated to this project?</li> <li>Is the quantity and quality of the publication record reasonable?</li> <li>Were presentations and publications made in the appropriate venues?</li> <li>To what extent has the program benefited from the results?</li> <li>How clear are the analysis results?</li> <li>Was the level of investment of resources in the analysis effort commensurate with the results achieved?</li> </ul>
<p><b>Future Direction</b></p> <ul style="list-style-type: none"> <li>Are plans (scope and approach) for future analysis in this area appropriate?</li> <li>Are the collaborations planned for future activity proper?</li> <li>Are peer review needs being adequately considered?</li> </ul>
<p><b>Overall Rating</b> – What are your summary views with respect to this study effort?</p>

In addition to providing comments for each project, the reviewers provided general comments on the overall strengths and weaknesses of the program and recommendations for strengthening future research activities. Prompts were used to guide reviewers in their overall, general comments. These prompts are provided in Exhibit 2.

<b>Exhibit 2 – Prompts for General Comments</b>	
<b>Focus</b>	<ul style="list-style-type: none"> <li>• To what extent is NETL’s systems analysis effort:                             <ul style="list-style-type: none"> <li>▪ Focused on critical issues important to future energy systems R&amp;D directions/needs?</li> <li>▪ Focused on gaps in existing and potential future (fossil and in particular coal) technology R&amp;D?</li> <li>▪ Being conducted and planned consistent with appropriate federal roles of “good stewardship” and technology leadership?</li> </ul> </li> </ul>
<b>Resources</b>	<ul style="list-style-type: none"> <li>• To what extent is NETL’s systems analysis effort:                             <ul style="list-style-type: none"> <li>▪ Being supported with human resources of appropriate skills?</li> <li>▪ Using tools and techniques and approaches appropriate to the studies being pursued?</li> <li>▪ Taking advantage of current knowledge in the “community” and incorporating it into the new analysis?</li> <li>▪ Being supported by NETL generally?</li> </ul> </li> </ul>
<b>Results</b>	<ul style="list-style-type: none"> <li>• To what extent is NETL’s systems analysis effort:                             <ul style="list-style-type: none"> <li>▪ Producing results that contribute materially to the overall objective of providing “steering wind” for future R&amp;D?</li> <li>▪ Producing results that are contributing to the external community’s knowledge and understanding of issues important to current and future technology R&amp;D directions/priorities?</li> <li>▪ Producing results that are contributing to DOE’s ability to formulate and defend important technology R&amp;D directions/priorities?</li> </ul> </li> </ul>
<b>Overall</b>	<ul style="list-style-type: none"> <li>• What are your summary views with respect to the NETL Systems Analysis efforts being conducted at NETL?</li> </ul>

The reviewer general comments in response to the above prompts are provided below in Exhibit 3 along with NETL responses.

<b>Exhibit 3 – Reviewer General Comments</b>	
<b>Reviewer General Comments</b>	<b>NETL Response</b>
<p>I agree that the systems analysis effort is focused on critical issues important to future energy systems research and development directions/needs</p> <ul style="list-style-type: none"> <li>• Focused on gaps in existing and potential future (fossil and in particular coal) technology research and development; and</li> <li>• Being conducted and planned consistent with appropriate federal roles of “good stewardship” and technology leadership.</li> </ul>	
<p>I am not sure that the current slate of activities represents the highest priority topics. If you asked each program area (HQ and field) to furnish you a prioritized list of their systems analysis needs, I think you would find good reasons to change your agenda.</p>	<p>This is a good idea that we could implement in some fashion.</p> <p>We work with the technology managers and NETL management early in the process to propose a slate of analyses. They are reviewed and prioritized by the SCC.</p>

<p>Focus should come from two major directions 1) over-reaching issues that concern the overall FE/NETL program goals, and 2) analysis needs of the individual Technical Program Managers. The optimum result, which appears to be occurring, would be for Senior Management and Technical Management to have a high degree of confidence in the results produced in a timely manner.</p>	<p>We currently have both portfolios of analyses in our mix. We have also instituted two subtasks that have broad scope defined and can be used to respond quickly to high priority requests that were not known at the start of the planning cycle.</p>
<p>System analysis should lead research and development efforts in terms of selecting the key technical areas to be investigated to reduce cost and improve performance. NETL is now getting the horse in front of the cart rather than behind. The analysis should be completed before most but not all research and development projects are initiated.</p>	<p>This is an excellent point. One important outcome of systems analysis should be to identify needs for new technology development and set cost and performance targets that they must attain to be worthwhile. This is already happening to some extent but can certainly be improved, especially in our relationship with OSER. For example, the Systems Team could be utilized to help characterize the potential benefits of OSER R&amp;D concepts and set systems-related experimental testing parameters.</p> <p>We are working towards that goal, but we have been able to re-direct R&amp;D with our results and identify new thrusts.</p>
<p>There seems to be a desire to investigate areas of low potential. This obviously reduces the resources that can be applied to high-potential areas. It is important that dead-end or potentially dead-end projects be terminated early so that resources can be reallocated. NETL should improve its performance in these two areas.</p>	<p>I would be interested to get some clarification of this comment. Are the areas being referred to NETL R&amp;D projects or NETL systems studies (or both)?</p> <p>Agree...but sometimes these analyses are needed to assist in terminating the R&amp;D. The justification needed to end a low potential R&amp;D project is often provided by these analyses. There is a difference between a low potential R&amp;D activity and a low potential analysis.</p>
<p>It seems the focus is very good. Although we did not get to see the entire systems analyses program, I have an impression that the program focus on most DOE identified areas of research and development needs.</p>	
<p>I would like to see more peer reviews and independent model validations.</p>	<p>Additional peer reviews would naturally result if the Systems Team more frequently distilled our reports into journal papers. The current version of QGESS contains some guidelines for model verification that we should consider implementing as appropriate.</p>

	We have made these peer reviews an annual routine and have instituted a process for getting highly visible analyses peer reviewed prior to release. Also, proprietary models and spreadsheets are being required to validate results against experimental data or other simulator tools.
From what we saw, the effort looks excellent, but I cannot make an overall judgment without seeing the other parts of the systems effort.	
It looks like you are being supported with excellent human resources of appropriate skills.	We have some very talented people in the group, but we continue to be understaffed with the current workload, especially the project management of site support contractor performed analyses.
It looks like the tools, techniques and approaches to the studies are generally appropriate, but I think you need some additional tools including a smaller (than ASPEN) process flowsheet simulator to enable faster turn-around and one that is available to the public so others can share input files, and models; you should also be developing new tools, like for example tools to predict scale-up.	<p>We are evaluating other tools. We do have plans to put our models in a library that is accessible to all parts of NETL as well as to the public. We do not have any current plans to develop scale-up tools.</p> <ul style="list-style-type: none"> <li>• Both Excel and ChemCad have been used for “quick and dirty” simulations, although some of our ASPEN experts might debate the notion that a quick turn-around is not possible with ASPEN.</li> <li>• If I correctly interpret a simulator that is “available to the public” to mean a simulator that is “free to the public” then I’m not sure that recommendation fits with NETL’s current mission.</li> <li>• It would be interesting to clarify what exactly would be expected from a “scale-up predictor” tool. A rough estimate of cost scaleup is one thing, but predicting the dimensional scaleup of a technology would be very technology-specific and would require CFD modeling in most cases.</li> </ul>
It appears you are taking advantage current knowledge in the “community” and incorporating that into the new analysis.	
I do not know if you are generally being supported by NETL – why are you asking me that?	
Based on FTE projections it appears that staff and consultant time is adequate to produce the required work product. Quality and skill of the team members appears to be excellent.	It would be interesting to do an FTE assessment for all the Systems work. I think we need at least one more person to perform our current workload adequately, especially if we are to avoid allowing subtask management

	<p>duties from monopolizing our time.</p> <p>We have some very talented people in the group, but we continue to be understaffed with the current workload, especially the project management of site support contractor performed analyses.</p>
<p>The presenters and research and development staff in the audience had a good overview of and technical understanding of the key issues in each project and the hurdles to be overcome. They appear to be well qualified for the system analysis work.</p>	<p>We utilize our site support contractors to find talent that we do not have within the federal workforce. We will be making a more concerted effort to involve the local university talent as well.</p>
<p>Setting up the library will be manpower intensive but is absolutely necessary. It should be given a high priority.</p>	<p>Agree.</p>
<p>NETL does have the capability to develop models and does have a vast data base.</p>	
<p>Whether or not we are reinventing the wheels in some cases, I can not judge. To the extent possible, it would be good to use what is already available and proven.</p>	
<p>It seems to be supported by NETL management.</p>	
<p>Some very sharp people doing the work. For others, supervisory attention is required to mentor and guide.</p>	<p>We now have a systems group with a team leader who will presumably fill that role.</p>
<p>As far as producing results that contribute materially to the overall objective of providing “steering wind” for future research and development – I do not know yet; at this point that seems to be TBD but off to a good start.</p>	
<p>Regarding producing results that are contributing to the external community’s knowledge and understanding of issues important to current and future technology research and development directions/priorities – I do not know because I have no knowledge of other’s use of your analyses.</p>	
<p>I would expect that current and future work will be producing results that are contributing to DOE’s ability to formulate and defend important technology research and development directions/priorities.</p>	
<p>Results from the early efforts appear to be of high quality. However it is important that consistency of results peer review play important roles in studies that are to be released for external consumption. For example if there is a “basecase” established</p>	<p>The 2006 Market Based Analysis will be providing the baselines for future activities. Additionally, the ASPEN models for these baselines will be available a starting points for future more advanced system analysis. Furthermore, the quality guidelines have been</p>

<p>for a technology it should be the same for all analyses or the differences clearly explained. In addition, when analyzing new technologies with little or no data, the staff should not be afraid to end or delay the analysis if they can not reasonably construct alternative data points.</p>	<p>revised and a DCF spreadsheet will be available for use by all parties. The DCF spreadsheet also allows the use of a capital charge factor as an option when a full DCF is not necessary (e.g. comparative studies)</p>
<p>Only a few of the projects that were discussed have been completed. It is hard to judge the impact at this time.</p>	<p>Perhaps future merit reviews should feature a strong majority of projects that have been completed.</p> <p>We should consider this for the next peer review.....we should be in a position by then to present completed work.</p>
<p>There should be a quality control function by management including a final review before distribution.</p>	<p>I agree with this! It seems that none of us has the time to do a thorough internal review of the reports produced by our federal colleagues and support contractors. Perhaps we should make it a requirement that at least two people do a thorough review of each report before it is finalized (or sent out for external peer review).</p> <p>A process for internal review is necessary and will be established.</p>
<p>I believe most all results produced from this effort will be useful to help direct/steer research and development efforts and set priorities for research and development both for in-house and industry efforts.</p>	
<p>Results are excellent for the completed work that we were shown. Work in progress seems both important and well focused.</p>	
<p>Overall the way the Systems Analysis activity has begun should insure that it becomes a very valuable part of FE/NETL's achieving its goals. Of equal importance it should provide DOE and the private sector with analytical information for policy makers and appropriators to justify program funding requirements in specific timeframes.</p>	
<p>I congratulate NETL on their progress in developing the systems analysis capability.</p>	
<p>There are several areas of improvement that are referred to in our previous comments.</p>	
<p>This capability should be used by NETL, headquarters and other DOE labs for impartial analyses.</p>	
<p>This is a very important and effective effort to guide research and development direction and</p>	

efforts.	
I would like to see a brief overview of NETL SA effort to get a feel of the overall program. Seem very complete so far.	Consider this as an introduction for next year's systems review.
I suggest more peer review and independent validation on model results.	
It may be good to "revisit" systems analysis that identified research area and confirm research and development focus.	Right. See comment for row four above. How can we implement this feedback loop?
I would like to see more communication like presentations or reports to share results.	We have set some OSAP metrics to get this information released in journals and conferences.
I look forward to when the model is accessible by outside entities. It will be a very useful tool for process optimization and validation.	This comment seems like it was specific to a certain project rather than general in nature.  This will become a reality in this fiscal year.
I was pleased and encouraged by much of what we were shown. Some adjustments are needed in some cases. It is important that all studies are well documented.	
There is a potentially large challenge for NETL senior management. How will NETL utilize negative findings from systems analysis? Will management terminate NETL research and development that appears unpromising, based on systems studies results?	This has already occurred in some of the sequestration and gasification projects. The OSAP systems team views itself as the honest broker and pledges to provide the facts, regardless of the popularity of the results. Indications to date show that management has accepted these results and acted upon them.

## Project Reviews

Following formal presentation and evaluation of the individual projects, the reviewers completed project evaluation forms. This section provides the salient comments provided by the review team for each project. These comments have been gleaned from the general discussion as well as from the individual project evaluation forms. A summary of the project ratings for each criterion is presented in Exhibit 4.

Exhibit 4 – Project Ratings							
Projects	Criteria	Reviewers					Overall
		Lau	Hirsch	Wootten	Wolk	Biondo	
A1. FutureGen: Multiple Selected Case Studies	Goals & Objects.	3	4	3	3	3	<b>3.40 Good</b>
	Key Challenges	4	4	4	2	4	
	Approach	3	4	3	3	4	
	Effect. & Results	3	4	4	2	4	
	Future Direction	3	4	4	2	4	
	<b>Project Overall</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>2</b>	<b>4</b>	
B1. Pollution Control Impact Study	Goals & Objects.	3	3	4	2	3	<b>1.75 Satisfactory</b>
	Key Challenges	3	3	3	1	3	
	Approach	2	3	2	1	2	
	Effect. & Results	1	NR	2	1	3	
	Future Direction	2	NR	4	1	3	
	<b>Project Overall</b>	<b>1</b>	<b>NR</b>	<b>2</b>	<b>1</b>	<b>3</b>	
B2a. Market- based Advanced Power Systems – Study	Goals & Objects.	3	4	4	3	4	<b>3.30 Good</b>
	Key Challenges	3	4	3	2	4	
	Approach	4	4	3	2	4	
	Effect. & Results	3	NR	4	2	4	
	Future Direction	3	3	4	3	4	
	<b>Project Overall</b>	<b>3</b>	<b>3.5</b>	<b>4</b>	<b>2</b>	<b>4</b>	
B2b. Market- based Advanced Power Systems – Tools Development	Goals & Objects.	3	3	4	3	3	<b>3.20 Good</b>
	Key Challenges	3	3	3	2	4	
	Approach	3	3	3	2	4	
	Effect. & Results	3	NR	4	2	4	
	Future Direction	3	3	4	2	3	
	<b>Project Overall</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>2</b>	<b>4</b>	
B3. Gasification Alternatives – Select Applications	Goals & Objects.	NR	NR	3	2	4	<b>3.00 Good</b>
	Key Challenges	NR	3	4	3	4	
	Approach	NR	3	4	2	4	
	Effect. & Results	NR	3	3	3	4	
	Future Direction	NR	NR	3	1	4	
	<b>Project Overall</b>	<b>NR</b>	<b>NR</b>	<b>3</b>	<b>2</b>	<b>4</b>	
B4. Gasification R&D Technical Pathways	Goals & Objects.	4	4	4	3	3	<b>3.10 Good</b>
	Key Challenges	3	4	3	2	3	
	Approach	4	4	4	2	3	
	Effect. & Results	3	NR	3	NR	3	
	Future Direction	3	3	4	3	3	
	<b>Project Overall</b>	<b>3</b>	<b>3.5</b>	<b>4</b>	<b>2</b>	<b>3</b>	

NR – Not Rated

Continued on following page

Exhibit 2 – Project Ratings							
Projects	Criteria	Reviewers					Overall
		Lau	Hirsch	Wootten	Wolk	Biondo	
<b>B5. Evaluating Novel Gas Concepts</b>	Goals & Objects.	NR	3	4	3	4	<b>3.67 Outstanding</b>
	Key Challenges	NR	NR	4	3	4	
	Approach	NR	3	3	3	4	
	Effect. & Results	NR	3	3	2	4	
	Future Direction	NR	NR	4	NR	4	
	<b>Project Overall</b>	<b>NR</b>	<b>NR</b>	<b>4</b>	<b>3</b>	<b>4</b>	
<b>C1. Sequestration Sorbents</b>	Goals & Objects.	4	4	4	3	4	<b>3.60 Outstanding</b>
	Key Challenges	3	4	4	3	4	
	Approach	3	4	3	2	4	
	Effect. & Results	4	4	4	3	4	
	Future Direction	4	4	3	3	4	
	<b>Project Overall</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>3</b>	<b>4</b>	
<b>C2. Sequestration Membranes</b>	Goals & Objects.	4	4	4	3	4	<b>3.60 Outstanding</b>
	Key Challenges	3	4	4	3	4	
	Approach	4	4	4	3	4	
	Effect. & Results	4	4	4	2	4	
	Future Direction	3	4	4	3	4	
	<b>Project Overall</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>3</b>	<b>4</b>	
<b>C3. Sequestration Solvents</b>	Goals & Objects.	3	3	4	2	4	<b>3.25 Good</b>
	Key Challenges	3	3	4	3	4	
	Approach	3	NR	4	3	4	
	Effect. & Results	3	NR	3	3	4	
	Future Direction	3	NR	4	2	4	
	<b>Project Overall</b>	<b>3</b>	<b>NR</b>	<b>4</b>	<b>2</b>	<b>4</b>	
<b>D1. PC OxyFuel System Evaluation</b>	Goals & Objects.	4	4	4	3	4	<b>3.50 Outstanding</b>
	Key Challenges	3	4	4	3	4	
	Approach	4	4	4	3	4	
	Effect. & Results	3	NR	4	2	4	
	Future Direction	3	NR	4	3	4	
	<b>Project Overall</b>	<b>3</b>	<b>NR</b>	<b>4</b>	<b>3</b>	<b>4</b>	
<b>D2. Approach Alternatives for H<sub>2</sub> Economy</b>	Goals & Objects.	3	3	3	3	3	<b>2.60 Good</b>
	Key Challenges	3	3	3	3	3	
	Approach	3	1	4	3	3	
	Effect. & Results	3	1	3	3	3	
	Future Direction	3	1	3	3	3	
	<b>Project Overall</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>3</b>	

NR – Not Rated

**Project Title:** A1. FutureGen: Multiple Selected Case Studies  
**Presenter:** John Wimer  
**Overall Rating:** 3.40 (Good)

**Project Abstract:** The objectives of this work are to provide technical definition, including assessment of candidate technologies and study of alternative plant configurations; government oversight and management of the project, including assessment of project objectives and potential negotiation issues, budget cost estimates for the project, compliance with DOE Order 413.3, and NEPA support; and guidance for the FE research and development program, including identification of fast-track research and development opportunities and assessment of integrating technologies tested into a full-scale plant. Accomplishments to date include assessment of candidate technologies, screening of alternative plant configurations, analyses of key technology choices and design issues, process integration, and detailed process analysis for “Project Plant” cases. Planned FutureGen System Studies include pre-combustion CO<sub>2</sub> removal designs for the FutureGen project plant (eastern and western coals), post-combustion CO<sub>2</sub> removal designs (eastern coals), next-step designs for combined-cycle FutureGen successor plants, next-step designs for combined-cycle FutureGen successor plants with co-sequestration, and liquid fuel co-product designs.

Reviewer Comments	NETL Response
This effort provides relative performance values for various FutureGen options.	1. No response required.
The goals and objectives are set already in the report to congress and reflect what was identified by the FutureGen Plant. Therefore key issues are clearly defined.	2. No response required.
Clear, well-defined issues. Easy to understand and appropriate for the nature of the externally-provided definition of the FutureGen project. Excellent.	3. No response required.
The needs and concerns of the industry participants have not been addressed; may be a function of the industry organization formation.	4. Agreed. At the time of the presentation the Industrial Alliance had not yet been formed and the best we could do was anticipate what their interests would be. Now that the Alliance is formed, we are in a better position to solicit their input.
The question of funding sources and amounts need to be factored into how plant might be configured.	5. Agreed. To date, the estimated capital costs of all “Project Plant” configurations have been within the defined DOE budget of \$950 million.
This work supports the goals and objectives of the program. I do not see in this presentation evidence of providing guidance for direction of research and development.	6. We chose not to emphasize this aspect in our presentation. However, based on our analysis, we did provide FE/HQ with a short list of advanced technologies that could be “fast tracked” under the core R&D program.
“Near Zero Emissions” is an issue for the base plant that needs to be addressed. Report to Congress (2003) emissions levels are not “near zero.” There are many states where the	7. This issue has been sent up the management chain and we have received guidance from FE/HQ.

<p>base plant could not be sited. HQ has issued the definition of near zero emission. Those should be used for the 2020 version of FutureGen. You need to come up with a creative way to characterize the emissions for the FutureGen plant and not call it near zero. The DAS OCP is insisting on a single definition for near zero.</p>	
<p>Also, there is a need to provide sufficient hydrogen to test a hydrogen turbine (enough of a test to validate capability) at the base plant.</p>	<p>8. This has been discussed with NETL's Technology Manager, Rich Dennis. If pre-combustion CO<sub>2</sub> capture is employed at the FutureGen project plant, the fuel provided to the gas turbine will essentially be hydrogen. In that likely case, a "hydrogen" gas turbine will be tested as a matter of course. Furthermore, this turbine could be modified to test advanced components during the course of the testing period. Rich Dennis does not think that "slipstream" testing of gas turbine components (such as a combustion can) makes sense for FutureGen because the turbine developers have their own labs set up for this purpose.</p>
<p>The use of analysis to identify key barriers is important. It appears that some unanticipated barriers and operational issues such as the unavailability of demonstrated technology for CO<sub>2</sub> capture from warm humid gas and less than 90 percent capture is likely with E-Gas technology because of methane production have been identified as a result of this work.</p>	<p>9. No response required.</p>
<p>No plan has been developed for coordination with the Alliance team.</p>	<p>10. When this presentation was given, DOE did not yet have an agreement in place with the FutureGen Industrial Alliance. Now that an agreement is in place, I anticipate that technical working groups will be set up to address topics such as our systems analysis work.</p>
<p>What is the DOE goal for this collaboration in terms of system analysis?</p>	<p>11. See above.</p>
<p>Utilization of the hydrogen is uncertain.</p>	<p>12. Agreed. Utilization of the hydrogen was not specified in the Report to Congress and will depend upon the site-specific design of the actual project.</p>
<p>Interaction and cooperation with the Alliance is key to the success of this project.</p>	<p>13. Agreed. See comment #10 above.</p>
<p>Differentiating the commercial and the research and development requirements of the FutureGen plant.</p>	<p>14. No response required.</p>
<p>There are many items to be evaluated,</p>	<p>15. The amount of resources that NETL</p>

gasification, gas cleanup, power island, hydrogen production and CO <sub>2</sub> capture and sequestration – perhaps too many for the level of manpower.	should dedicate will be determined after an agreement with the FutureGen Industrial Alliance is in place.
Challenges are design, technology selection, and integration, based on current and projected state-of-the-art. Shows an excellent understanding of challenges, options, and demands.	16. No response required.
It is not clear that climate and geographic criteria are being paid the proper amount of attention; i.e., western locations that might impact design, altitude, temperature, water availability, and coal type.	17. The series of studies we currently have planned will address the impacts of coal type. The impacts of altitude and water availability will likely be deferred until more guidance from the Industrial Alliance is obtained and/or the site selection process is farther along.
It appears that the many issues and barriers are being addressed. I do not think the states' regulatory requirements are being adequately addressed. I do not think the stated cost and efficiency will be attractive to private sector investors.	18. Based on the guidance we ultimately receive from the Industrial Alliance, we may take a closer look at the differences among state permitting/regulatory requirements. It is agreed that the stated cost and efficiency of this first-of-a-kind research project would not be very appealing to private sector investors.
Comprehensive analyses of multiple technologies.	19. No response required.
How much of the cost issues are considered during technology evaluations?	20. The costs of technologies built into the plant at full scale are fully considered. Assessments of the costs of advanced technology modules to be tested during plant operations are generally being done by NETL Technology Managers rather than under this study.
There appears to be adequate input from industry and vendors for their study.	21. No response required.
The approach is clear and thorough.	22. No response required.
Modeling is not clearly related to experimental work.	23. Experimental data is being utilized to the extent it is available for the advanced technologies we are modeling in FutureGen configurations.
Excellent top down approach and framework for addressing the design issues.	24. No response required.
In spite of the government ground rules, an open issue beyond NETL's control is the question of how much FutureGen is "commercial" versus a vehicle for research and development. This question needs to be better defined between the government and the industrial contractors in the not too distant future.	25. Agreed. No response required.
The project is called "systems analysis" but in fact it is a hybrid of systems analysis and	26. Agreed. No response required.

preliminary project engineering.	
Excellent command of literature and analysis techniques.	27. No response required.
Excellent approach – need to be certain western coal issues are addressed.	28. Agreed. Cases with western coals are being completed.
Excellent analytical framework.	29. No response required.
Need to resolve commercial issues for the plants operation.	30. Agreed. This will be part of our negotiation with the Industrial Alliance.
Compliments existing efforts but is much needed new effort.	31. No response required.
Coordination appears to be excellent.	32. No response required.
There are too many questions to answer if I also have to comment; so I will answer the questions:	33. No response required.
NETL's command of literature and analysis techniques looks comprehensive, but why not dynamic modeling in addition to steady state? When do you get into control issues?	34. Pending guidance from the Industrial Alliance, dynamic modeling to address control issues will likely be deferred until the conceptual design of the project plant is selected.
Approach appears to be coherent.	35. No response required.
Framework and level of detail is probably appropriate but cannot know for sure from this cursory review.	36. No response required.
Method is fairly transparent and key assumptions are articulated, but it is pretty abstract and slap-dash.	37. The analysis is abstract by necessity, largely due to the fact that no agreement is yet in place with the Industrial Alliance and the plant design is not yet defined even at the conceptual level. I am not sure exactly what "slap-dash" means, but it does not sound good.
Assumptions are appropriate except for regulatory assumptions.	38. See comment #18 above.
Results were not discussed in detail so do not know how they were compared; I will take your word for it.	39. No response required.
I do not know about communication and collaboration from this presentation.	40. Very little communication or collaboration is possible for this analysis until after an agreement is in place with the Industrial Alliance.
Proposed effort is probably not duplicative and probably complementary.	41. No response required.
It appears you have adequate resources but my guess is your need more people doing flowsheet simulations.	42. See comment #15 above.
I do not know about the coordination between modeling and experimental work in the field from just listening to this review.	43. See comment #23 above.
The possible post-2015 operation of the plant has not been considered in evaluating cases.	44. To some extent, we have considered how post-2015 operation might affect the conceptual design of the plant, especially in

	terms of carbon capture. This was articulated during the presentation.
Yes the approach and results address most the issues of FutureGen project.	45. No response required.
Will we be using the results of this study to guide the project after the FutureGen Alliance come on board?	46. Yes.
How much of the results of this study be shared with the Alliance?	47. It is anticipated that all the results will be shared with the Alliance, to the extent that it does not compromise DOE's negotiation position; e.g., prematurely reveal details of the government's cost estimate.
Yes the publications and results are reasonable for the projects.	48. No response required.
The results are clearly stated but not clear they are consistent; i.e., apple and apples comparisons, necessary due to differences in technologies more suitable to some coals for example.	49. I would need to clarify this comment before responding.
Results to date are impressive for a relatively modest number of FTEs. Progress is excellent. Approach is very logical, which translates to the high effectiveness of the effort.	50. No response required.
Appears to be on tract, but results to date are limited for making a judgment.	51. No response required.
Critical issues are addressed except perhaps for environmental permitting.	52. See comment #18 above.
It looks like technical progress was adequate.	53. No response required.
I do not know if publication record is reasonable. Who cares? Who are your stakeholders?	54. See comment #47 above.
Publications should be distributed to FE HQ – full publications with results; not just abstracts and summaries.	55. As final reports are completed, they will be shared with FE/HQ and NETL Technology Managers.
Programs could benefit substantially from the results, particularly if program staff from both HQ and NETL are involved.	56. See comment #55 above.
I have not seen all the results.	57. No response required.
Resources could be commensurate with results.	58. No response required.
There are number of studies planned that deal with additional gasifiers, gas turbines, etc. There should be more studies that focus on areas that promise cost, reliability, and efficiency improvements.	59. Although FutureGen will be an R&D facility rather than a demonstration plant, studies that focus on cost reduction and reliability improvement may be appropriate depending on how the project is structured. In addition, such studies are being routinely performed by NETL Technology Managers.
Planned future work including FT liquids is desirable.	60. No response required.

Need to focus more on research and development needs that will help meet future FutureGen plants.	61. The current analysis is focused primarily on the FutureGen project plant. Although some thought is being given to “Next Step” FutureGen plants, such studies are primarily being independently conducted by NETL Technology Managers.
Maybe open up for more peer review.	62. Agreed. Additional peer review will be obtained directly from the Industrial Alliance.
Carbon sequestration is not defined.	63. Carbon sequestration for the FutureGen Project Plant is being analyzed under a separate project.
Need to coordinate activities very quickly with FutureGen Alliance ASAP.	64. Agreed. No response required.
Excellent and logical. I liked the range of options to be considered.	65. No response required.
Excellent approach – do not drop other coal and gasifier configurations, add climate and geographical variables.	66. See comment #17.
Future plans look fine; would like to have you get HQ program managers comments on them and get inputs before proceeding.	67. I defer this issue to NETL management; however, I believe that they consider the current method/level of interaction between NETL and HQ (especially Vic Der) to be appropriate with regard to FutureGen system studies.
There are a number of activities that are still in progress that would have raised the score if more results had been available.	No response required.
This work is definitely needs to be done, appears to be done competently and is leading to insightful conclusions.	No response required.
Important evaluations for the FutureGen project and future research and development needs.	No response required.
Need coordination with FutureGen Alliance.	Agreed. See comments #40 and #62.
Outstanding. Approach and description was open, flexible – certainly not dogmatic.	No response required.
I think this is an excellent approach to support a very important project. The analysis needs to, as soon as possible, factor in the needs and concerns of the industrial partners to insure a successful project. I do not know how this process factors in the concern that the project scoped at \$950M may only receive partial funding.	Agreed. See comments #40 and #62.
More time should have been allocated for this review. An entire day would have been adequate.	No response required.

**Project Title:** B1. Pollution Control Impact Study  
**Presenter:** Michael Reed  
**Overall Rating:** 1.75 (Satisfactory)

**Project Abstract:** Objectives for this quick response project were to provide input to EPA with respect to technical performance, capital cost, and economic performance for increasing SO<sub>x</sub> and NO<sub>x</sub> regulation on IGCC systems, increasing NO<sub>x</sub> regulation on NGCC systems, and comparison of IGCC and NGCC to conventional PC boiler systems in the present regulatory environment. Accomplishments include analysis of 11 different systems; delivery of credible technical, capital cost, and financial performance information to FE HQ; and establishment of credibility with EPA for future work. Future efforts will include assessment of steel prices and fuel costs, additional gasification types, additional coal types, and advanced steam systems for PC boilers.

Reviewer Comments	NETL Response
Not related to research and development; analysis requested by EPA.	Not all analysis is related to NETL R&D. There is a policy component that needs to be met. This study was developed as a technical information source to assist FEHQ personnel in the engagement of EPA over policy. This is an acceptable role for the division.
Great opportunity to work cross Department, in this case DOE and EPA.	
Yes the issues are clearly defined by EPA.	
Clearly defined issues.	
Appears to met EPA's objectives; I do not see connection in guiding the direction of FE research and development.	
Issues may be clear to EPA but since EPA limits are not as low as some states, this analysis is too conservative to guide FE research and development.	
Well defined issues.	
Consistency checks among input data was not done carefully.	Limited QC due to limited time. Will need to do better under similar circumstances.
Management review before delivery of the report to the customer is required for a consistency check.	Will be part of future QC system.
Short turn around time.	
Need to define the basis of analyses so results can be compared.	
Good understanding of the issues and what was needed to provide a credible response in an extremely short time. The tight time requirements may have been such that NETL needed to tell the customer that it was not possible to provide credible results under the circumstances.	
This was strictly environmental with a	

superficial look at economics	
I do not believe that the study identified the emission levels for PC that are being permitted today.	
Inadequate command of relevant literature and analysis techniques.	
Approach was OK for establishing the delta in cost for additional cleaning.	
No, method is not transparent.	
Assumptions were not discussed.	
No, technical and economic results were not compared in an appropriate and unbiased manner.	Miscommunication at the review meeting by the speaker. Results for all analysis are assumed to be nth plant. Speaker gave the wrong impression that numbers were first of a kind. FOAK numbers for IGCC plants would be roughly 20 percent higher.
Communication and collaboration are poor.	
Approach is mutually defined by EPA and DOE.	
Sufficient cases to cover a range to provide adequate comparison.	
Assumption and results need to be clearly stated.	
There had to be expertise in-house to be able to meet the externally imposed time requirements.	Not yet. Part of long term vision for OSAP is to bring more expertise in to DOE.
The basis for the study seemed reasonable.	
The options considered seemed reasonable.	
I cannot evaluate the concerns expressed by one of the other reviewers, but his concerns require attention.	
This particular analysis should have been better coordinated with people at NETL and HQ. It should have been cleared through FE-HQ.	Analysis was defined and final approval was from FE-HQ.
Fair command of literature and analysis techniques – need to look at levels being permitted today.	
Results are not consistent with majority studies for comparison of technologies.	
Need more information to identify differences between technologies.	
Do not appear to be based on cost results.	
Appears to be a problem based on other studies.	
Appears to lacking based on COE results.	COE was included as part of the study but not adequately presented at the review meeting.
Work is complimentary to other efforts underway.	
Assuming that the critical issue is delivering a	

consistent result to EPA, that goal was not achieved.	
Need to revisit analyses due to concerns/inconsistencies brought up by Wootten.	
Inconsistencies probably due to assumptions/uncertainties/basis used in the analyses.	
Seemed reasonable under very tight external requirements. I am in no position to question the results, which another reviewer did question. The results should have been carefully reviewed internally before being released.	
Giving exact numbers is not the best way of displaying results under these circumstances. An error bar approach would have been more desirable.	Error bars would render the analysis useless and require a longer more expensive effort than was requested. If a risk/uncertainty approach is required, then the entire study would have to be redone. Also, an education of the customers of this type of analysis will have to be educated to fully understand the results.
I do not think there is a consensus on the results and I do not know what the effectiveness will be.	
I do not think the capital cost and financial analysis reflect credible results.	The results are credible based on similar results from the now completed Market Based study. The problem was with the presentation and the poor communication of the basis for the numbers. The impression was mistakenly given that the numbers would apply to an IGCC FOAK plant when they are actually n <sup>th</sup> plant.
This study should not be released until issues of comparing technologies can be resolved.	Results were given to a very limited audience based on raised concerns.
The case for the PC plant needs to be reworked.	
There were no appropriate peer reviews made at NETL.	Unavailable due to lack of time.
Need to revisit analyses results, inconsistent with industry studies.	
Potentially more cooperation in the future between Departments is great and should be capitalized.	
Future direction seems reasonable for the circumstances dictated by the customer. If the objections raised by another reviewer are correct, then the whole study needs to be revisited and the findings may need to be significantly revised.	
I believe that pollution control impact studies should be done taking into account the current	Need to perform work to find out what the different states standards are so that can be

state's lowest permitting levels. FE is supposed to be developing technology that can be sited in any state in the U.S. – not necessarily in any site in any state, but in all states. FE needs to get these studies done and that is higher priority than servicing EPA.	included in quality guidelines.
Future studies with EPA should be coordinated through FE-HQ.	
Expand to include other coals and technology options as well as technology developments in IGCC and air emission levels for PC plants.	Not possible under time constraints. Possible subject for future work.
The study may be valid for the gasification cases 7-11. However no detail was provided about the assumptions for those cases so that in is not possible to decide if there are OK.	
The inclusion of numbers for PC, which was prepared by a different contractor using different assumptions was inappropriate.	
Overall, there was no oversight to detect the “smoking gun” of higher COE for current PC plants versus nth IGCC plants.	New organization has an “oversight” capability/role for the team leaders.
Need to revisit analyses.	
Great opportunity for cooperation between Departments and DOE NETL to provide input.	
Cannot rate based on the concerns raised by one of the other reviewers. His concerns indicate the need for more careful internal review before results are released.	
Adequate review before release is always important, and even more so when they are supersensitive, as is true in this case.	
Good effort given the time constraint, but next time do not let time constrain the quality of the analysis.	
Study needs to be reviewed before released.	

**Project Title:** B2a. Market-based Advanced Power Systems: Study  
**Presenter:** Julianne Klara  
**Overall Rating:** 3.30 (Good)

**Project Abstract:** The objectives of this work are to compare performance and cost on a consistent basis of currently available technologies and consider shifts in power industry since 1998 study was published, including state-of-the-art NGCC and coal-fired power plants, capture of approximately 90 percent CO<sub>2</sub> from NGCC and coal-fired power plants, production of salable SNG from gasification and re-powering of existing NGCC facilities with SNG. Key accomplishments are PC and NGCC cases have been completed (six of 15 cases), gasification case work is underway, ASPEN models are under development for delivery to NETL, and training of NETL personnel in systems analysis techniques continues. This is expected to be a “benchmark study” on which many other studies build over time. Work planned for FY 2006 includes completion of remaining IGCC cases, completion of final report, continue involvement with vendors for cost and performance data, and continue collaboration with EPRI’s Coal Fleet of Tomorrow.

Reviewer Comments	NETL Response
Updating previous studies to reflect current circumstances is needed.	
Hydrogen is not included in this co-production, done in FutureGen project?	This study is focused on market-based (defined as commercially available in the next 5 years). Hydrogen may be considered in a follow-on effort that looks at longer term advanced technologies.
Is the issue being addressed clearly defined – updating an earlier study expanded to include CO <sub>2</sub> and SNG in support of DOE program objectives.	
The project makes excellent sense. Goals are realistic. The product should be extremely useful in many ways for the future.	
The term “market-based” does need to be defined explicitly up front, per one of the questions.	This definition has been included in the upfront section of the final report.
Good benchmark study	
This report as performed in the past and was extremely valuable. Repeating the study with updated information is an ongoing requirement that should be repeated periodically; e.g., five years. It reestablishes the baseline that is used to define research and development requirements – must have.	
Issues clearly defined.	
More consistency is needed relative to definitions of technology readiness, such as “market-based.”	This definition has been clarified in the final report.
New areas of focus are included such as CO <sub>2</sub> capture and SNG.	

Not much is new in SNG production in recent years.	Do not disagree, but we needed a consistently derived cost and performance estimate.
Challenges are well understood.	
Appropriate issues and barriers have been adequately addressed.	
Well defined for the most part with two critical concerns 1) getting good vendor information, and 2) emission control information is driven by required compliance levels this may not reflect capability or guaranteed performance. IGCC emission levels is driven by process (turbine) requirements not emission requirements and therefore is lower. Need to consider how to get at best emission control levels not permit levels.	Vendor information continues to be a difficult challenge. In its absence, the contractor is using its vast expertise in designing power plants.  Emission controls are set based on what we expect in the next five years. We continue to explore how to best highlight the IGCC's superior environmental performance.
The approach appears to be appropriate.	
There should be an attempt to review contractor bias in cost numbers.	A peer review of the draft final report has been included in the schedule in an attempt to ensure accuracy and to identify any biases.
Standard assumptions should be imposed on contractors (capacity factor, financial treatment, etc.).	The development of the NETL Quality Guidelines for Energy Systems Studies addresses this need for standardization.
Has well defined databases both in-house and outside companies. Easy to follow.	
Updated 1998 study is needed with recent advances in the technology area.	
SNG and CO <sub>2</sub> update is definitely needed to for the data base.	
Not much recent development in SNG.	Do not disagree, but we needed a consistently derived cost and performance estimate.
NETL has capability to conduct study.	
Approach is very reasonable.	
The issues and challenges are very well understood.	
There are too many questions here to answer.	This comment is assumed to refer to the length of the response form rather than referring to the study.
The approach is sound and communication could be more effective if the systems analyses were published on the NETL website. Also, include the ASPEN input files.	The report will be posted on the NETL website. All cases will have ASPEN files that will be available by request through our systems analysis library.
Regarding duplication, I think I have see much of this already published. The findings are pretty obvious and already well known.	Disagree....most analyses available are not done with consistent design basis or financial assumptions.
Approach is excellent with the addition of consideration of other climate, geological and coal quality considerations.	A follow-on analysis is planned to address other coal types.
Generate base cases as planned but expand	A follow-on analysis is planned to address

to include western sites with western fuels.	western coals.
The approach appears OK. However, only part of the project results, namely the PC cases, was available for this review.	
The critical results for IGCC were not available and therefore cannot be used yet for overall research and development guidance.	IGCC results will be available in January 2006 and will be peer reviewed before release.
The analyses so far address the PC with NGCC adequately and the results are consistent with expectation. Results seem consistent.	
Need to complete the comparison with IGCC plants.	IGCC results will be available in January 2006 and will be peer reviewed before release.
Publications and presentation is expected this year.	IGCC results will be available in January 2006 and will be peer reviewed before release. Final release may not happen until June 2006.
Results indicated significant penalty for CO <sub>2</sub> capture. Indicate more work to be done in this area.	Justifies need for sequestration R&D program.
The work seems to be progressing very well. There is much more to be done and then ground-truthing with industrial experience will be required.	A peer review of the draft final report has been included in the schedule in an attempt to ensure accuracy and to identify any biases.
The results are clear and the analysis is adequate to address the issues.	
I do not know about how the level of resources compares with the results.	
Results have been widely used in the past and should be in the future. Detail of results allows reader to understand how number is derived which should help reader understand differences.	
Because technology development in this area is a quickly moving target a one-year effort may be too long, perhaps more resources could allow for six-month turn around.	Will consider this when determining the schedule for the follow-on effort with western coals.
Completion of this work will be important to establish baselines	
Need to complete IGCC comparison.	IGCC results will be available in January 2006 and will be peer reviewed before release.
Peer review not mentioned?	A peer review of the draft final report has been included in the schedule in an attempt to ensure accuracy and to identify any biases.
The plans for completion are appropriate. In fact, this baseline should be treated as a work in process that should continue to evolve over time.	
Future directions are good. I would rather see the posting on the NETL website instead of	Both will be done.

the peer review but both would be fine.	
Excellent with expansion described above and periodic repetition.	
This work will be useful.	
Update is necessary for the 1998 study to reflect the recent advances in technology.	
It would be nice to have consistent assumption and basis; such as coal and gas prices, capacity factors, etc.; for these studies across NETL.	The development of the NETL Quality Guidelines for Energy Systems Studies addresses this need for standardization.
This is an extremely important effort. It will provide an essential baseline for a wide range of future systems studies.	
This is a work in progress that appears very well directed and very well executed.	
Good work.	
This is a very valuable effort for the entire coal research and development program because it reestablishes the baseline from which research and development needs can be defined.	

**Project Title:** B2b. Market-based Advanced Power Systems: Tools Development  
**Presenter:** Michael Reed  
**Overall Rating:** 3.20 (Good)

**Project Abstract:** The objectives of this work are to establish an infrastructure for storage and reuse of systems work, establish standards for systems files and documentation of this work, establish an “Internal Clearinghouse” to perform work necessary to transfer study results into NETL’s library, and establish a standard procedure for dissemination of systems work to entities outside NETL via the Clearinghouse. Accomplishments to date include validation of SharePoint as archive software, demonstration of initial archive with EPA study and 2004 transport gasifier study results, delivery of initial training, and gathering feedback from users. Future work includes finalization of library structure, population of the library, development of technical and costing modules as appropriate, and continued development of SharePoint archive and associated standards.

Reviewer Comments	NETL Response
Very good concepts of what needs to be done to support the systems analysis program	
Meets the objective of NETL's ability to standardize and capacity building.	
Establishing a standard database is essential to consistent study by NETL.	
Making available to others outside NETL will be very useful.	
This work makes excellent sense. Important for NETL and the outside world.	
Goals and objectives are sound but not broad enough to include the needs of potential users at HQ and the public.	
Other people could use the ASPEN input files and also need to be able to run them without having to buy a license from ASPEN. You should either update the original ASPEN FORTRAN code or modify the CMU software to run ASPEN files. Contrary to what you say, CMU indicates that is quite feasible.	Not feasible. Cannot run AspenTech files without the AspenTech software. Projects are being considered for creation of reduced order models that could be transferred to CMU.
You should also plan to get access to the source code CMU developed for DOE – buy them out?	
Also, you have another option: use a smaller process flowsheet simulator for exercises that do not require ASPEN. That would dramatically increase your productivity and the results would be more readily available to the public.	What simulator? Cost and knowledge development of another flowsheet simulator?
The establishment and operation of a “clearinghouse for dissemination of technology research and development results is essential for identification of follow on research and	

development results and commercialization of research and development.	
Issues are clear.	
Key challenges are not discussed in any detail.	
Key challenge – large database to organize.	
Good understanding of key challenges.	
There is a concern related to the vulnerability of ASPEN to commercial failure or abandonment. NETL should have a contingency plan, just in case.	Not a major concern at this point.
Key challenges have been identified and addressed.	
Understanding of the magnitude of the clearinghouse concept appears to be well understood, as well as the need for ongoing, long-term support.	
The approach seems appropriate.	
The approach is well defined.	
Impact of scrubbed database from vendors needs to be clearly stated.	Will be stated in the initial documentation of the systems library.
The approach makes excellent sense.	
The vulnerability of this effort to the health of the company providing the ASPEN software requires careful consideration.	Not a concern at this point.
The development of the library will be extremely useful.	
It would have been useful to have first found out what computational approaches the major A&E firms have used, to have benefited from their experience, and to be compatible with what is out there to the degree possible.	
The approach is fine for the limited goals and objectives. It is quite coherent and comprehensive.	
Approach appears to be sound with further consideration of the potential for the public software which is the basis of the system could go away and the system would need to be flexible enough to shift to another platform.	
The effort appears well planned.	
This is the beginning of a large effort.	
Largely an organization, documentation, verification, and standardization effort, very much needed.	
It is a work in process. It is admirable that they asked outsiders to test an early version and have responded to the concerns expressed.	
This is tools development and most of the	

bullets are not relevant. I would expect the results to be effective, but they could be more effective.	
It appears that a workable system has been produced.	
The planning seems appropriate but more collaboration with outside organizations will be useful.	
Future plans are well defined.	
This will be a very useful tool once complete.	
You need a long-term commitment from NETL to maintain the system.	
Future direction seems very reasonable.	
Future plans are reasonable and realistic. Regarding peer review, consider getting input from HQ program managers and include them in your user community.	
Future direction is well thought out.	
Plans seem appropriate, but much remains to be done before there is a usable system.	
Outside companies should be consulted about how they have done similar things.	Need examples from reviewers.
Establishing a standard database is essential to consistent study by NETL.	
Validation of the model is also very important.	
Still dependent on ASPEN.	
Since proprietary data are scrubbed, it is important to point out applicable data range, interpret rather extrapolate data.	
This will be extremely useful. It is a work in process.	
This is a good thing to do but there is a lot more that can be done. You need to spend more time choosing and developing the most appropriate tools to do the job.	
This development activity is a necessary component to a well-defined research and development program.	

**Project Title:** B3. Gasification Alternatives: Select Applications  
**Presenter:** Jeff Hoffmann  
**Overall Rating:** 3.00 (Good)

**Project Abstract:** The goal of this study is to determine the applicability of GTI's U-GAS<sup>®</sup> fluidized bed gasifier in an industrial setting and for utilization of lignite coals (four distinct cases). Conclusions derived from this study are that industrial combined heat and power gasification facilities may be competitive with other options and lignite IGCC is economically attractive, with some issues remaining. Benefits to the program include that through this initial look at small-scale gasifiers, barriers and research needs were identified; this is a fresh look at GTI's U-GAS<sup>®</sup> technology; and significant NETL systems analysis capacity building has been accomplished.

Reviewer Comments	NETL Response
Industrial coal gasification for fuel gas production and IGCC may represent a small niche market, but will have limit[ed] impact on the program research and development plans.	Response 1 – Industrial coal gasification is being considered a potential avenue for improved domestic energy security. DOE/FE/NETL is currently collaborating with EERE exploring the benefits of such applications. This study supports that collaboration and expands OSAP's knowledge base in the subject area.
The technical issues for performance improvement for U-GAS type gasifiers were identified.	Response 2 – OSAP recognizes the importance of identifying technical issues as part of conducting thorough systems studies.
The justification for NETL doing this study is open to question. Why should NETL be doing work for the narrow interests of one particular organization? Is NETL open to any industrial partner asking for similar studies of their technology? Why not? Bottom line: The justification for this project is open to question and it may set an undesirable precedent.	Response 3 – While this study did look specifically at GTI U-GAS technology, OSAP should be sensitive not to characterize studies as <i>“doing work for the narrow interests of one particular organization”</i> . There are times when analyses based on technologies from single organizations or industrial partners make sense. U-GAS is one of few technologies that have commercial history of similar size and application (Shanghai Coking and Chemical). In this case, considering a near term build would likely require a technology of sufficient maturity such as the U-GAS.
Goals and objectives are clear.	Response 4 – OSAP recognizes the importance of clearly identifying goals and objectives as part of conducting thorough systems studies.
This is very useful for understanding the potential and barriers for coal-based DG.	Response 5 – One of the findings of this study was that industrial applications can have significantly different technical and economic barriers compared to large central power stations. OSAP should consider articulating these differences in systems

	studies guidelines and provide appropriate guidance for conducting studies where such differences have significance.
The goal is narrow in that it reflects the application of only one specific technology and as such has limited support of overall program.	Response 6 – For specific technology application see Response 3, for limited program support see Response 1.
The key barriers were identified and suggestion for improvements identified.	Response 7 – See Response 5. OSAP recognizes that inclusion of suggestions for technology improvements in thorough systems studies can provide input to effective program direction. This is one value of OSAP that should be promoted throughout the organization.
Technical challenges seemed well understood.	Response 8 – See Response 2
The key challenges appear to have been addressed.	Response 9 – See Response 2
Key challenges have been identified.	Response 10 – See Response 2
The overall job was well done, but it is essentially irrelevant to program needs. The major value appears to be training of personnel.	Response 11 – Regarding program needs see Response 1. The training component is recognized as a valuable aspect of this activity and is part of the Organization's commitment to building internal systems analysis capacity.
I question the approach that involved GTI providing gasifier and material balance data. The study results will bear NETL's name, yet NETL does not seem to be in a position to verify the GTI inputs. Indeed, a less than honest vendor could use an NETL analysis for their own selfish interests.	Response 12 – This is an important point that was recognized throughout the study yet may not have been adequately addressed in publications and presentations. NETL and OSAP often utilize vendor supplied data and at times do not have appropriate resources to independently verify or validate such information. At times vendor data may be a result of proprietary processes. Where data integrity may be of issue, OSAP should consider consistent methods to differentiate between vendor-provided data and data that have been independently validated, either internally or by a third party.
It is important to differentiate between the questionable basis for doing this project and what appears to be very competent work by the speaker, who seemed quite capable.	Response 13 – Regarding the basis, see Responses 1, 3, and 12. OSAP strives to demonstrate proficiency and capability to execute competent and relevant systems studies.
Speaker has an excellent command of the relevant literature and analysis techniques.	Response 14 – OSAP strives to demonstrate proficiency and capability to execute competent and relevant systems studies.
There is a coherent approach that builds on previous research and analysis efforts and complement on-going efforts.	Response 15 – See Responses 2, 4, and 14.
Analytical framework and level of detail were appropriate.	Response 16 – OSAP strives to conduct systems work at the level of detail that is

	appropriate to generate results of quality suitable to meet required needs. See Responses 2, 4, and 14.
Method is transparent and the assumptions were articulated well.	Response 17 – See Responses 2, 4, 5, and 14.
Technical, economic, and performance assumptions were appropriate.	Response 18 – See Responses 2, 4, 5, and 14.
Technical and economic results were compared in an appropriate and unbiased manner.	Response 19 – See Responses 2, 4, 5, and 14.
Effective communication and collaboration in this meeting. I do not know about with others in the field, including in-house and contracted research for NETL.	Response 20 – Communication and collaboration with technology developers and in-house R&D were instrumental to selection of candidate technologies and trade-off studies that were conducted as part of this analysis.
Resources appear to be adequate.	Response 21 – See Response 29.
I do not think this duplicates other efforts, and it does complement/supplement DG.	Response 22 – OSAP tries to leverage and compliment other work rather than duplicate it. Current efforts within OSAP to build model libraries should allow continued, more effective studies that support NETL's programmatic interests.
Approach appears to be well thought out and implemented.	Response 23 – See Responses 2, 4, 5, and 14.
Analysis results adequately address critical issues. The improvements suggested for small-scale gasifiers were good.	Response 24 – See Responses 2, 4, 5, 7, and 14.
Regarding publications, report available, but quality unknown.	Response 25 – Report was subject to review deemed appropriate by project participants, including subject matter experts at participating organizations (DOE/NETL, Nexant, GTI, & Industrial Partner) that were not directly involved with project execution. OSAP recognizes the importance of credible analyses and considers appropriate peer review instrumental to maintaining recognition as experts in the field. OSAP continues to seek appropriate level peer review for studies conducted by its staff.
Public use of knowledge gained is uncertain.	Response 26 – The applications studied in this analysis represent a relatively unexplored market. With rising fuel costs, coal gasification may become an option considered for use in industrial applications. This is an early step in evaluating the suitability of gasification in the industrial market and will augment the FE/EERE collaborative effort identified in Response 1.
Analysis results are very clear.	Response 27 – See Responses 2, 4, 5, and

	14.
It seems that the major value was training.	Response 28 – See Response 11.
Overall, the amount of resources allocated for this work seems excessive.	Response 29 – Because training of NETL resources in systems analysis was an important component of this study, the amount of resources were greater than would be required to execute the study by personnel with appropriate experience and capabilities. NETL has gained increased systems analysis capacity as a result. OSAP should likely consider developing a structured approach to capacity building to ensure that resources are appropriately utilized.
The analysis seems to have been very well done.	Response 30 – See Responses 2, 4, 5, and 14.
Results adequately address the critical issue.	Response 31 – See Responses 2, 4, 5, and 14.
Adequate technical progress was made based on the technical challenges and resources allocated to this project.	Response 32 – See Responses 2, 4, 5, and 14.
The quantity and quality of the publication record are reasonable.	Response 33 – See Responses 2, 4, 5, 14, and 34.
Presentations and publications were made in the appropriate venues.	Response 34 – OSAP recognizes the need for technology and information transfer. Publication and presentation of study results are often required as part of annual staff performance plans and the OSAP Operational Plan.
DG and gasification programs have benefited from the results.	Response 35 – See Response 26
Analysis results are clear.	Response 36 – See Responses 2, 4, 5, and 14.
Level of resources is appropriate.	Response 37 – See Response 29.
The study conclusions do not seem to fit results 1) industrial gasification applications of GTI U-GAS do not meet reasonable hurdle rates for a new technology, usually greater than 20 percent; and 2) lignite case also presents a marginal ROI for new technology.	Response 38 – Disagree. In brief, the study concluded that industrial-scale gasification can be competitive under certain circumstances. However, it is unlikely to be the least-cost option for power and steam generation, and drivers are likely to be non-economic (i.e., improved environmental performance or energy security) that were not quantified in this study.
The program may benefit from results if one were to conclude that this technology need not receive further development for these applications unless significant changes in economics are anticipated.	Response 39 – Disagree in part. Study indicates that power island and bop components contribute significantly to unfavorable economics, in many cases due to the loss of economy-of-scale. Program may also benefit by focusing R&D resources on specific process areas that offer the largest impact on improving the economics and/or

	performance.
No future activities planned.	Response 40 – This study is completed and there are no direct follow-on activities planned. However, NETL plans to continue to explore industrial applications of gasification technologies through collaboration with EERE. See Response 1.
Good liaison during project with technology developer and potential user.	Response 41 – See Response 20.
There is a real question about the advisability of NETL undertaking such a narrow study. It would be more reasonable to look at a range of gasifiers and to identify pros and cons, which is what is being done in other projects.	Response 42 – Agree with comment regarding reviewing a variety of gasifiers and pros and cons. Regarding narrow study, see Response 3.
Future plans are appropriate.	Response 43 – See Response 40.
Peer review was adequately considered.	Response 44 – See Response 25.
Future direction is unclear.	Response 45 – See Response 40.
I do not know the plans for future collaboration.	Response 46 – See Response 40.
Project complete. Improved industrial gasification may be of interest to the market.	Response 47 – See Response 26.
A paper describing these results should be published. It may generate interest in the marketplace.	Response 48 – See Response 34.
It is a very important first look at feasibility of industrial size gasification unit and an IGCC for lignite.	Response 49 – See Response 26.
I cannot rate a study that does not seem to be justified.	Response 50 – See Responses 1, 3, and 12.
It is too bad this was not done two or three years earlier.	Response 51 – No response.
There are benefits to looking at small gasification applications, and this is one subset of that analysis. Unfortunately the results were not positive for pursuing this application.	Response 52 – See Responses 26, 38, and 39.

**Project Title:** B4. Gasification R&D Technical Pathways  
**Presenter:** Julianne Klara  
**Overall Rating:** 3.10 (Good)

**Project Abstract:** The objectives of this work are to identify the most effective technologies to improve efficiency and reduce costs of IGCC, and to guide NETL research and development funding. IGCC technology baseline plant configurations have been developed for bituminous and PRB coals with and without carbon capture. Benefits include updated IGCC DOE baseline plant configurations that can be compared to standard plant designs under development by GE, EPRI (Coal Fleet), ConocoPhillips, and Shell; and validation of other studies looking at similar configurations. Plans for FY 2006 include completion of systems analysis study to quantify impact of developing technology on IGCC, continuation of collaborations and work to establish dialogue with other gasification technology manufacturers. Collaborators include EPRI (Coal Fleet), GE, Parsons, Shell, CP, and GTC.

Reviewer Comments	NETL Response
The plan to guide research and development is appropriate.	Not only appropriate, but absolutely necessary for setting goals and determining progress and benefits of the program.
Objective is well defined, to support DOE gasification program.	
Another update from past study.	Updating past studies is important. Periodically the analyses must be reviewed and determine if changes in technology, market, or policy may impact the results significantly. If so, then an update may be warranted.
Potentially a lot of new improvements were available since the last study.	
Outstanding. You are asking the right questions; addressing the right issues.	
This analysis supports the program goals and objectives and should be useful in guiding research and development.	
The issues are clearly defined.	
Study will identify future research and development benefits to performance and costs – very valuable.	
Issues are clear.	
The plan to address these issues is aimed correctly.	
Obtaining data from developers/vendors will be challenging.	This analysis will depend heavily on the market based study. However, vendor information continues to be a difficult challenge. In its absence, the market study is using the contractor's vast expertise in designing power plants. This analysis has the added difficulty of determining estimates for performance and cost on advanced

	technologies. If not well known, sensitivity analyses on performance will be conducted.
At the higher level, the right questions are being considered. The challenges of extrapolating from lab-scale to commercial-scale are recognized. The work is not far enough along to make fine-scale judgments.	
The barriers and issues are being addressed in an appropriate manner.	
The approach looks at successive improvements but does not try to quantify the probability that any particular step will be achieved. Perhaps the analysis could look at a high achievement case and a low achievement case?	Will consider probabilities in coordination with the benefit risk analysis project.
More effort is needed on defining standard assumptions and checking for consistency.	The development of the NETL Quality Guidelines for Energy Systems Studies addresses this need for standardization.
Good handle of what needs to be done. Key is to get relevant data for this update.	
Speaker has a good handle on industry needs.	
NETL is well equipped to conduct this work.	
Speaker is working with outside support as well.	
Results will be presented in GTC conference.	This is the plan.
Approach seems quite reasonable. Asking many (all?) the right questions.	
The approach is clear and coherent.	
Communication appears to be effective.	
Resources appear to be adequate.	
Approach is sound and uses existing resources. Could be better if it gave some indication of the probability of success of incremental developments.	Will consider probabilities in coordination with the benefit risk analysis project.
The plans address the critical issues.	
Regarding results - early stage in project, baseline cases are completed.	
I would like to see consistency in basis of calculations.	The development of the NETL Quality Guidelines for Energy Systems Studies addresses this need for standardization.
You are doing the right kinds of things.	
Work is in an early stage and can only be judged as a work-in-process.	
I agree with the suggestion of rounding off the results as a means of indicating the inexactness of the calculations.	
Analysis results appear to adequately address the critical issues.	
The program should benefit from these results.	
Level of investment is adequate.	

This effort addresses critical issues but needs to be consistent with other studies or characterize the level of effort (detail) put forward in one study versus another which would explain differences if any.	The development of the NETL Quality Guidelines for Energy Systems Studies addresses this need for standardization. Will consider how to characterize the level of effort when documenting studies.
The plans for evaluation of potential benefit are appropriate.	
Good in-house and outside support, including vendor involvement.	
You may want to expand study to include other co-products, H <sub>2</sub> , SNG, and FT liquids.	These technologies are being considered in this effort, but under the direction and management of a colleague.
Future direction seems appropriate. After the results are in, it will be important to have a careful, detailed review, including outside experts.	Peer review of results is planned for this effort.
Future work is appropriate. Additional reviews, not just peer reviews should be helpful.	Not sure what is meant by additional reviews...not just peer reviews. If intended to mean individual reviews of the final product, this is planned.
Publishing a set of baseline information for a matrix of climate, geographic, and coal quality variables would very valuable for gauging next steps in research and development.	This is something that I believe that SAP needs to wrestle with. It requires a sort of meta analysis of all studies and development of a method to communicate what is learned and where there are gaps that R&D can help fill. We could do a much better job than we currently are.
Consistency of requirements needs to be established for both outside contractors and NETL personnel.	The development of the NETL Quality Guidelines for Energy Systems Studies addresses this need for standardization. Will consider how to characterize the level of effort when documenting studies.
The level of accuracy and detail need to be published along with each study.	This is so true in this analysis since some of the more advanced components cannot be modeled in detail or due to lack of experimental data are a lower level of accuracy.
Timelines should be defined in terms of technology status.	This has been done.
Reliability should be added as an objective along with cost and efficiency.	This is included.
Very important work to identify areas needing research and development to accomplish DOE goals for gasification.	
You need vendors to comment on the results.	We try to work with the vendors to get the data. When we cannot, we ask them for their comments. Problem is, if there technology does not look like a winner, they tell you the work is not right. But then they are not willing to provide you with the information needed to

	correct/adjust it (if that is really what is warranted)
Should consider H <sub>2</sub> , SNG, and FT liquids?	These are considered and included in the set of cases, but for the systems review, only the straight power cases were discussed.
Well presented.	
I cannot yet judge; work is in process. Tentatively good-outstanding.	
This looks like good work.	
Good project with check on consistency with other analyses that address similar technologies.	This analysis will be working the 2006 Market Analysis to avoid duplication, ensure consistency, and to provide a checks and balances of the analyses.

**Project Title:** B5. Evaluating Novel Gasification Concepts  
**Presenter:** Julianne Klara  
**Overall Rating:** 3.67 (Outstanding)

**Project Abstract:** Two separate technologies were evaluated for this project, 1) the Rocketdyne/Boeing compact gasifier, and 2) the Stamet pump.

*Analysis of Rocketdyne/Boeing Compact Gasifier for IGCC Applications* – The objective of this effort is to provide independent assessment of potential efficiency and/or cost improvements of novel compact gasifier concept over current state-of-the-art. The key result is that developer performance projections of greater than \$200/KWe reduction in capital and greater than \$3/MWh reduction in cost of electricity were confirmed and continued analysis and research and development on this concept is warranted. Information is needed to make informed decisions for research and development spending and to determine progress toward ultimate research and development goals. Work planned for FY 2006 includes completion of the compact gasifier analysis, generation of a final report, and potential updates as gasifier development proceeds.

*Analysis of Stamet Pump for IGCC Applications* – The objective of this effort is to prepare a report that shows the impact of replacing conventional IGCC solid feed systems with the Stamet dry feed pump. Results indicate that the Stamet pump offers an advance in efficiency and cost over the current lockhopper technology in all analyzed cases. Information was provided to the NETL technology manager for research and development program planning. No follow-on work is planned.

Reviewer Comments	NETL Response
I am uncomfortable with NETL doing studies specific to a vendor's technology separate from other similar concepts. To me, new concepts should be evaluated on a comparative basis; e.g., a new gasifier <u>in the context of other gasifiers</u> .	This was discussed at length in the peer review. It should be clarified that this analysis is not to assist the vendor on improving his technology as it competes against others, but it is to provide valuable insight to the technology manager on an existing (and competitively awarded) activity regarding whether the next phase should be pursued.
My comments are based on the assumption that this work cannot be kept internal to NETL. In addition, what is to stop another vendor to demand that NETL evaluate their concept?	We do generate results that are for our planning purposes and are not released externally. We only investigate concepts that have been proposed and/or awarded in a competitive procurement.
The two examples presented clearly show support for the goals and objectives of the program (gasification).	
This is the precise use that the analysis function should fill – screen technologies and their research and development needs for their ability to achieve the programs goals.	
The issues that are addressed were clearly defined.	
Key challenges are well understood.	
The key challenges to be addressed were	

analyses of novel concepts under considerable uncertainty due to the lack of data and information.	
Good solid approach for novel approaches with little or no data.	
The approaches were appropriate and well done. While there was no mention of it, I think the approach is well suited to find out “what is wrong” with a proposal and that is very important for decision making under extreme uncertainty.	We have been consulted for review/analysis or proposed concepts for proposal review panels.
I think some thought should be given to using and developing methods for predicting scaling-up processes and systems.	No current plans for scale-up tools. Is this part of OSAP mission?
To repeat, I am uncomfortable with NETL doing studies specific to a vendor’s technology separate from other similar concepts; i.e., not in context.	I disagree that we are looking at this concept without comparing to other similar concepts. We have evaluated this novel gasifier against other existing and competitive gasifier types.
The analyses are preliminary and in some cases, more detailed effort may be required.	
Solid approach, but you should not be afraid to back away from analysis if data is not available.	This is something the systems team should consider as a way to eliminate some of the workload. The fluorinated solvent analysis was terminated for just this reason....not enough data to do any useful modeling.
Some of the system analyses seem to have been done at a superficial issue.	???
NETL’s analysis will be competent. I have concerns with NETL doing this kind of service work for a contractor. I worry about the possibility of misuse of NETL analysis and manipulation of NETL.	This was discussed at length in the peer review. It should be clarified that this analysis is not to assist the vendor on improving his technology as it competes against others, but it is to provide valuable insight to the technology manager on an existing (and competitively awarded) activity regarding whether the next phase should be pursued.
The results clearly and adequately addressed the critical issues.	
This type of application for screening analysis and identification of research and development potential should be done for internal use only.	It is.
The work should be continued.	
It appears that the work is nearly complete.	This is not the case. Progress has been slow, but the contractor has increased its resources for this effort and NETL has provided committed resources within OSAP and OSER to expedite this activity.
Plans for future analysis presumably would assume refinement of the current approaches as more experience is gained.	We continually update our analysis as new information becomes available if it is believed that it will significantly improve the accuracy and/or results.

This is critical to yield go or no go calls on research and development pathways.	
I do not think peer review is applicable here.	Agree....for peer review of the report. However, this is the type of project that benefits from having the approach peer reviewed as was the case in this instance.
This function is very important in providing research and development guidance for allocation of research and development funds.	
In-house due diligence studies like these are very helpful/important to PM decision making process.	
Job is well done.	
I agree with NETL's approach to Rocketdyne review.	
I am interested in why dry and slurry feed system did not change process efficiency for the Stamet system.	I will have to look into this.
I would like to see COE for the cases.	This comment was made during a review of the draft final report and the contractor was asked to provide this information.
I must abstain from rating this work as I am on project team.	
I am uncomfortable with NETL doing studies specific to a vendor's technology separate from other similar concepts.	This was discussed at length in the peer review. It should be clarified that this analysis is not to assist the vendor on improving his technology as it competes against others, but it is to provide valuable insight to the technology manager on an existing (and competitively awarded) activity regarding whether the next phase should be pursued.
Overall I think this is excellent work and very useful.	
Use of the analysis in this fashion is a critical component to finding successful pathways to the program goals.	

**Project Title:** C1. Sequestration Sorbents  
**Presenter:** Jared Ciferno  
**Overall Rating:** 3.60 (Outstanding)

**Project Abstract:** *Mg(OH)<sub>2</sub> Sorbent* – The objectives of this effort are to provide a quantitative engineering assessment of a pre-combustion CO<sub>2</sub> capture technology utilizing the Mg(OH)<sub>2</sub> sorbent and provide guidance to researchers to improve the performance and cost of pre-combustion, temperature swing absorption CO<sub>2</sub> capture systems. The approach includes CO<sub>2</sub> capture system conceptual design, integration of the CO<sub>2</sub> capture system into an existing plant using a spreadsheet approach, entry of performance and cost data into the NETL Economic Model, and performance of sensitivity analyses to optimize system design. Work planned for FY 2006 includes systems studies on other advanced sorbents and continued tool development to enhance turnaround time for future systems studies. For Mg(OH)<sub>2</sub>, sensitivity cases will be run to establish research and development targets.

*Post-combustion Amine-enriched Solid Sorbents* – This effort's objectives are to provide a quantitative engineering assessment of the amine-enriched solid sorbent technology for CO<sub>2</sub> capture and provide guidance to researchers to improve the performance and cost of solid sorbent-based CO<sub>2</sub> capture systems. The approach includes CO<sub>2</sub> capture system conceptual design, integration of the CO<sub>2</sub> capture system into an existing plant using a spreadsheet approach, entry of performance and cost data into the NETL Economic Model, and performance of sensitivity analyses to optimize system design. Work planned for FY 2006 includes updating analysis as more information becomes available, identifying generic performance metrics, and continuing to develop tools to enhance turnaround time for future systems studies.

Reviewer Comments	NETL Response
This work is extremely important in determining how to allocate research and development funding	Agree.
The goals and objectives of this project are very much needed to help research and development direction to meet DOE program goals.	Agree.
Excellent understanding of what is needed and the challenges of going from small scale data to what might be at commercial scale.	Agree.
Excellent sense of direction.	Agree.
Analyses support program goals and objectives. Analyses are clearly defined.	Agree.
Very supportive of program goals and objectives – low-cost approach to gauging potential of new sorbents.	Agree.
Issues being addressed are very clear – engineering assessment and research and development guidance to managers.	Agree.
The key challenge is to determine when to begin the assessment work relative to beginning the experimental work.	Yes, this is a key challenge and was noted by NETL management at the time of the merit review. The question as to what should come first, analysis or experimental work, is an

	issue that may be addressed by the NETL focus leads and Technology Managers.
Recognize the lack of large scale up data.	Agree.
More literature data needs to be included to make analyses more complete.	Yes, at the time of the presentation, little external data was used. Based on verbal recommendations during the merit review, the second half of the study involved the incorporation of literature data.
Many are on early stage of development.	Agree.
Key challenges are well understood.	Agree.
Understanding of key challenges is the goal of these analyses.	Agree.
For Mg sorbent, I recommend looking at a warm S removal system to be certain that development will enable sorbent success.	Yes, this is very important and not the first time this issue has been brought up. The success of warm S removal would be required for this particular CO <sub>2</sub> sorbent. However, the approach taken is to analyze the CO <sub>2</sub> sorbent under the most optimistic conditions (i.e. assume warm S removal is viable). If the CO <sub>2</sub> sorbent results show substantial promise, then it is recommended that researchers continue with the development (and vice versa), independent of the warm S removal technology. There is a separate path (funded through gasification) for warm S removal.
The question of S removal technology has to be addressed together with the sorbent evaluation question. The use of an assumed warm gas cleanup can lead to incorrect results in the solid absorbent step.	
At this point, there should be an assessment of what needs to be accomplished in terms of technical development that would lead to achievement of the goals of meeting Selexol performance and the ultimate goal of limiting the increase of COE to 10 percent.	Agree, and this assessment has been completed (although not presented at the merit review). NETL has developed a CO <sub>2</sub> capture economic model and has run multiple technology scenarios (mini analyses) that incorporate different technologies. For example, O <sub>2</sub> membrane plus H <sub>2</sub> /CO <sub>2</sub> membrane plus co-sequestration of H <sub>2</sub> S/CO <sub>2</sub> will provide a path to 10% increase in COE.
There is a need to check enhanced WGS catalyst projects to assess what their potential is.	Does not apply to this analysis. WGS sorbents are being developed and depending on available data, may be analyzed Fall 2006.
Good approach to analysis. However, you need to look at available data outside of NETL to help review results.	At the time of presentation, analysis was half way complete. Based on this verbal comment during the presentation, NETL did obtain external data and references that pertained to this sorbent and yes, the data definitely assisted us in evaluating the results. The NETL results were consistent with similar published data (sorbent has inherent low CO <sub>2</sub> capacity).
Do we have similar model/systems with other sorbent types?	Yes, fluidized, fixed and radial flow bed models exist for the evaluation of Amine

	enhanced sorbents being developed at NETL.
Excellent understanding of how to do effective and useful systems studies. Asking the right questions and calculating the important parameters. Shows an excellent understanding of the issues.	Agree.
Approach is sound and comprehensive.	Agree.
Command of literature and techniques appears to be sound.	Agree.
Analysis and level of detail are appropriate.	Agree.
Methods are transparent and clearly articulated.	Agree.
Resource planning appears to be appropriate.	Agree.
Good command of relevant literature and analysis techniques.	Agree.
Coherence of approach is excellent.	Agree.
Yes, analytical framework and detail level are appropriate – if results for Mg are favorable second effort requires matching to warm S technology.	Agree.
Yes, method is transparent and assumptions are articulated properly.	Agree.
Yes, technical, economic, and performance assumptions are appropriate.	Agree.
Yes, technical and economic results were compared in an appropriate and unbiased manner.	Agree.
Panel had suggestions for other research and development to be considered.	Suggestions noted at time of merit review. No action required at this time from OSAP.
Analysis results adequately address critical issues.	Agree.
Level of investment of resources in the analysis effort was commensurate with the results achieved.	Agree.
The results are very insightful in determining whether this approach will meet the project targets and what it would take to beat conventional processes.	Agree.
You need to provide recommendations to researcher and managers for decision making as results indicate.	Final report definitely provides recommendations to researchers.
Outstanding. Speaker showed he understands the issues and the important factors. Results are very credible and instructive.	Agree.
The technology programs could benefit from these results.	Agree.
Completion of the work and documentation is absolutely necessary.	Very well documented, transparent final report delivered November 2005.

Some of the other work in this area (amine enhanced sorbents) by European researchers presented at the CO <sub>2</sub> conferences should be reviewed.	Followed up on recommendation by researching the European information and including it where applicable.
Good to look at other sorbents.	In the planning for FY 2006.
Is there a sorbent that works between low and high temperature that address the high level heat issues?	Yes, they are known as “mild temperature” sorbents and will be evaluated starting December 2005. These mild temperature sorbents are a mix of chemical (amine) and physical (selexol) chemicals.
Doing the right things and moving in the right directions. Outstanding. Be sure to finish the studies and prepare reasonable documentation for current use and future reference.	Agree. Very well documented final report delivered November 2005.
Plans for future work are appropriate and well thought out.	Agree.
I do not know about the collaborations.	No Comment. I do not recall discussing collaborations.
Yes - initial results identify short comings of these two sorbent approaches, information needs and development required to meet goals.	Based on results, all reports include a “reverse engineering” section such that targets are provided to researchers to meet the program goals for any particular technology.
Based on this preliminary analysis, program seems to be moving beyond this Mg sorbent approach. This may be warranted. Identification of what issues must be resolved and their probability of resolution should be addressed before either approach is abandoned.	R&D program direction is decided by Technology Managers and R&D Focus Leads. Important role of analyses are to provide these leaders with quality information such that program decisions can be made.
The work is very good and provides valuable information both to the researchers and management.	Agree.
Very useful and insightful results.	Agree.
I would like to see more integration with outside/literature data for systems analyses.	Comment well taken and agree. Integration with other studies will be a priority to future studies.
Outstanding. This is the way systems analysis on new and alternate concepts should be done.	Agree.
Overall I think this is excellent work.	Agree.
Good projects that will address go/no go decision on further work for these two sorbent approaches.	Agree.
It is hard to see another way in which the viability of the approaches could be determined without spending significant research and development dollars.	Agree.

**Project Title:** C2. Sequestration Membranes  
**Presenter:** Jared Ciferno  
**Overall Rating:** 3.60 (Outstanding)

**Project Abstract:** *CO<sub>2</sub> Transport Membrane* – Hybrid alumina/organosilane membrane was studied and a final report was delivered in May 2005. Objectives of this work are to provide a quantitative engineering assessment of a CO<sub>2</sub> transport membrane technology and provide guidance to researchers to improve the performance and cost of CO<sub>2</sub> transport membrane systems. Results include identification of performance goals for CO<sub>2</sub> selective membrane technology and establishment of a membrane model for future assessments. Research and development has been redirected away from CO<sub>2</sub> membranes for power plant CO<sub>2</sub> capture.

*H<sub>2</sub> Separation Membranes* – Thermally optimized polymeric membrane study is underway and Pd/Cu alloy membrane study will begin in the fall of 2005. Objectives of this effort are to provide a quantitative engineering assessment of advanced H<sub>2</sub> membrane separation technologies and provide guidance to researchers to improve the performance and cost of membrane separation systems. Progress to date includes development, testing, and debugging of membrane model; addition of WGS kinetics to the membrane model; and development, testing and debugging of the Aspen IGCC system model. Work in FY 2006 includes completion of the assessment of the LANL membrane, assessment of LLNL SLIP (Solvent-Less In-Situ Polymerization) technology, and assessment of the benefits of a membrane reactor.

Reviewer Comments	NETL Response
This work supports program objectives well.	Agree.
Issue being addressed is clearly defined.	Agree.
The objectives are consistent with DOE program goals.	Agree.
Excellent understanding of what is needed.	Agree.
Analyses clearly support gasification program goals and objectives and issues are clearly defined.	Agree.
Goals right on target to support program goals and objectives.	Agree.
Issue being addressed is very clear.	Agree.
The barriers have been well considered.	Agree.
Database is good from NG industry.	Agree.
Regarding key challenges, small scale data for syngas applications.	Agree.
Excellent understanding of the challenges and issues.	Agree.
Challenges are technical challenges, and they have been identified and are being addressed.	Agree.
At this stage of development performance parameters and preliminary costs are the pivotal considerations – they are being addressed.	Agree.
Well done regarding command of literature and analysis techniques.	Agree.
Approach is very coherent.	Agree.

Technical, economic, and performance assumptions? Many of these are still to be delivered.	These assumptions exist and are well documented in the final report. However, they were not highlighted during the merit review presentation. Will use this comment to set the stage better next time.
Approach is very logical.	Agree.
Speaker understands the various first order issues.	Agree.
If and when membranes get into the ballpark of interest, then issues of impurities, etc. will be important to study.	Agree.
Good command of the relevant literature and analysis techniques.	Agree.
Approach is sound.	Agree.
Adequate resources appear to have been planned to conduct the effort.	Agree.
Proposed effort complements and supplements other work being conducted in this area, and/or is unique.	Agree.
It appears that communication and collaboration are effective with others in the field, including in-house and contracted research for NETL.	Agree.
Results compared in an appropriate and unbiased manner.	Agree.
Technical assumptions are appropriate.	Agree.
Methods are transparent and assumptions are clearly articulated so that others can review and compare results.	Agree.
Analytical framework and level of detail are appropriate for conducting credible analyses.	Agree.
Approach is coherent. Efforts build on previous research and analysis efforts and complement on-going efforts.	Agree.
Yes, analysis results adequately address the critical issue.	Agree.
The results, particularly on CO <sub>2</sub> membranes should be used by researchers to redirect their projects.	The results and targets to meet the program goals are documented in each study. It is the responsibility of the NETL R&D focus leads to change program direction based on the system results.
Results are again very informative and useful to guide and assess research.	Agree.
Outstanding. The type of results that one hopes for from systems analysis.	Agree.
Clear picture emerged from the CO <sub>2</sub> membrane studies.	Agree.
The hydrogen membrane studies should be very instructive, also.	Agree.
Results appear to adequately address the	Agree.

critical issues.	
Good technical progress was made.	Agree.
I would expect gasification program to benefit from results.	Agree.
Analysis results are clear.	Agree.
Level of resources commensurate with results.	Agree.
Results presented are very preliminary on CO <sub>2</sub> and to be determined on H <sub>2</sub> , but appear to be heading in a direction that would provide a basis for shifting, or perhaps in the case of CO <sub>2</sub> discontinuing, the work as originally set.	These results are crucial to guide the program direction. The results and targets to meet the program goals are documented in each study. It is the responsibility of the NETL R&D focus leads to change program direction based on the system results.
Yes, plans (scope and approach) for future analysis in this area are appropriate.	Agree.
Yes, collaborations planned for future activity are proper.	Agree.
Plans are to complete the work on CO <sub>2</sub> membranes and prepare documentation.	Final report on the CO <sub>2</sub> selective membrane was completed and delivered internal to NETL R&D.
Directions for the hydrogen membrane analysis seem very appropriate.	Agree.
Future plans appear to be proper.	Agree.
The first level membrane model appears to be acting as an initial screen for go/no go. This has been done for CO <sub>2</sub> and will be completed for H <sub>2</sub> . Moving to process model development (Aspen) may be premature?	The development of the ASPEN model will help expedite membrane assessments and improve the accuracy of the results, especially in the performance area. The H <sub>2</sub> membranes will involve N <sub>2</sub> sweep gas and water gas shift integration—this would be difficult to perform using a spreadsheet model.
The membrane model has value on its own and could be used by other labs and contractors to assess their membrane work.	Currently working with LANL to assess their high temperature polymer membrane. Discussions with LLNL to assess their Solventless In-Situ Placement (SLIP) membrane technology is taking place. Analysis of the SLIP is planned for May 2006.
The overall effort provides strong guidance for research and development.	Agree.
Very useful result to guide research and decision process.	Agree.
You may want to peer review results.	Current CO <sub>2</sub> selective membrane analysis underwent internal peer review. The H <sub>2</sub> selective membrane work is more detailed with more advanced models and the plan is to have the work peer reviewed by the following: University Consortium, LLNL and LANL engineers, NETL in-house and possibly private companies such as NEXANT.
The performance of the membrane model will need to be model, such as a CFD modeling.	The plan is to perform the 1 <sup>st</sup> level systems analysis to assess viability. As the

	technology progresses in the lab, CFD modeling will be the next appropriate step. In this particular membrane analysis, Pall Corporation is working on the CFD portion and assisting NETL with the results as well as costs.
Good presentation.	Agree.
Excellent work.	Agree.
Development of the membrane model to look at performance and costs is a necessary step to provide the technology managers guidance for determining viability and further work.	Membrane model will be applicable to assessing various types of membranes. It is well documented, flexible and easy to use.

**Project Title:** C3. Sequestration Solvents  
**Presenter:** Julianne Klara  
**Overall Rating:** 3.25 (Good)

**Project Abstract:** Objectives of this effort are to evaluate feasibility of using novel fluorinated solvents for CO<sub>2</sub> capture at elevated temperatures (400 – 500K) in an IGCC plant, provide costs and parameter targets for a fluorinated solvent system in order to be competitive with the Selexol case, and develop a tool to evaluate future warm gas clean-up systems on a consistent basis. The project team is currently modifying an ASPEN model of a complete IGCC plant without CO<sub>2</sub> capture to serve as a base case and modifying the base case simulation to incorporate a WGS unit and a two-stage Selexol unit for CO<sub>2</sub> capture. Work planned for FY 2006 includes completion of the fluorinated solvent system analysis by October 2005 and continuation of evaluation of other warm CO<sub>2</sub> capture concepts using tool used for this study. No follow-on work is planned unless new data or designs become available for this concept.

Reviewer Comments	NETL Response
This is an area with expectations for significant improvement.	
Goals are consistent with DOE goals for CO <sub>2</sub> capture.	
To a reasonable extent this analysis supports program objectives and assists in guiding the direction of research and development	
This analysis provides a useful technique that supports program goals and objectives and assists the direction of research and development.	
Identified performance and costs for approach are right goals.	
The issue is clearly defined.	
The challenges are well defined.	
Regarding key challenges - early stage research and limit data.	
Key challenges seem to be understood. Work at an early stage. The limits of what can be usefully done for the state-of-the-art seem to be well understood.	
The key challenges appear to have been identified and addressed.	
To a very appropriate extent the proper technical, environmental, economic, regulatory, and policy issues and barriers in this area of analysis have been identified and addressed.	
The approach has been appropriate for a project with relatively low potential for improvement.	
Done literature data is good.	
Well position to use the tool for the systems	

analyses.	
Regarding the approach, it sounds real but at too early of a stage to judge.	
The approach used here is the object of value.	
Novell approach presents special needs for extrapolating data from similar processes because no actual data exists. Need to be careful not to over extract data to fulfill analysis commitment.	This was not done. In fact, due to lack of actual experimental data, the analysis was terminated and will be pursued at a later time if and when data are available that indicate that the process could show some advantage.
Yes, analysis results adequately address the critical issue.	
Results are indicative of lack of potential for this solvent for warm gas cleanup.	
Too early to judge effectiveness and results.	
The results effectively showed that fluorinated solvents are not feasible for carbon capture.	
Yes, plans (scope and approach) for future analysis in this area are appropriate.	
Too early to judge future direction.	
Future plans are to use this “tool” for screening other promising, or not promising, alternatives.	
Appropriate to stop here unless new data is discovered that increases its ability to achieve program goals.	This was the case. Due to lack of actual experimental data, the analysis was terminated and will be pursued at a later time if and when data are available that indicate that the process could show some advantage
A quick look is appropriate.	
What was the early indication to begin this effort? Answer: Solvent is stable and high CO <sub>2</sub> capacity.	
Good to have a model to accommodate warm solvent systems.	
Overall, reasonable but too early to judge.	
Overall this is good work.	
Good high-level analysis that should go no further.	Agreed.

**Project Title:** D1. PC Oxyfuel System Evaluation  
**Presenter:** Jared Ciferno  
**Overall Rating:** 3.50 (Outstanding)

**Project Abstract:** Objectives of this effort are to validate previous and future oxy-fuel studies, confirm the NETL Level II Systems Analysis Projections; assess the technical and economic feasibility of co-sequestration with CO<sub>2</sub>, SO<sub>x</sub>, and NO<sub>x</sub>; assess the integration of novel O<sub>2</sub> membrane technologies (Praxair and Air Products); flush out system barriers that prevent technology success or areas that require further research and development to reach commercialization; compare to IGCC; and produce peer reviewed and published results. This project began in July 2005. Extensive process simulation is being accomplished in ASPEN and cost estimation will rely on inputs from process simulation. Work planned in FY 2006 will include follow-on analysis to assess low-sulfur Powder River Basin coal for selected systems.

Reviewer Comments	NETL Response
This effort should provide a baseline for oxyfuel combustion relative to standard PC plants.	Agree.
Goals consistent with DOE goals.	Agree.
Outstanding. Very important to do the work and have base cases for status evaluation and future studies of alternatives.	Agree.
Effort supports program objectives and assists in guiding the direction of research and development.	Agree.
Issues being addressed by the analysis are clearly defined.	Agree.
The oxy combustion needs to be evaluated against a near-zero emission supercritical PC base case with CO <sub>2</sub> capture and an IGCC base case with CO <sub>2</sub> capture. There may also be a retrofit/re-powering issue here for applicability to existing plants.	Both of these suggested cases are contained in this project. Significant oxy-fuel retrofit studies have been performed by ALSTOM. Due to funding constraints and to prevent duplication of work, we chose to stick with greenfield installations.
The appropriate technical, environmental, economic, regulatory, and policy issues and barriers in this area of analysis have been identified and addressed.	Agree.
Challenges are well established, similar to other new technologies, need acceptance by the industry.	Agree.
The appropriate technical, environmental, economic, regulatory, and policy issues and barriers in this area of analysis are understood.	Agree.
The appropriate issues and barriers of this analysis have been identified and are or will be addressed.	Engineers are very aware of the issues and the approach to address these issues will be highlighted in the report.
Expand challenges to include retrofit applicability or eliminate it as a possibility.	Significant oxy-fuel retrofit studies have been performed by ALSTOM. Due to funding

	constraints and to prevent duplication of work, we chose to stick with greenfield installations.
The approach looks coherent.	Agree.
Care should be taken that the technology selections for the future ultrasupercritical oxyfuel plant and the future IGCC plant reflect the same time frame for availability.	Agree and some changes have been made to the design basis. The PC plants will be for the 2010-2015 timeframe and adjustments to the IGCC cases will be made to reflect this time range.
You might consider other researchers in oxy combustion work.	Studies by ALSTOM, Foster Wheeler and IEA GHG association were researched and results from these studies were used to frame the NETL study.
Many cases are considered, well bracketing the various scenarios.	Agree.
Cases are well defined.	Agree.
Excellent progression from earlier work. Very logical.	Agree.
The relevant literature and analysis techniques are taken into account.	Agree.
The approach is coherent and builds on previous research and analysis efforts and complement on-going efforts.	Agree.
The analytical framework and level of detail are appropriate to conduct credible analyses.	Agree.
The method is transparent and assumptions are articulated so that others can review and compare results.	Agree.
The technical, economic, and performance assumptions are appropriate.	Agree.
Technical and economic results are compared in an appropriate manner.	Agree.
Communication and collaboration is effective.	
Proposed effort complements/supplements other work being conducted in this area.	Agree.
Expand approach to include retrofit/re-powering applications.	Significant oxy-fuel retrofit studies have been performed by ALSTOM. Due to funding constraints and to prevent duplication of work, we chose to stick with greenfield installations.
No results are available yet. The plan looks good.	Agree.
Early work no results yet	Agree.
Very impressive results.	N/A
Discussion of effectiveness and results is not applicable.	New project. No results presented at time of Merit Review.
Yes, analysis results adequately address the critical issue(s). I cannot wait for results.	Agree.
Plans (scope and approach) for future analysis in this area are appropriate.	Agree.

Collaborations planned for future activity are proper.	Agree.
Seems to be well planned future efforts.	Agree.
Collaborations planned for future activity are reasonable and appropriated.	Agree.
Excellent idea to expand to western coal applications.	Agree.
This study will help define whether oxyfuel combustion will provide a potentially competitive option for future coal power plants operating in a CO <sub>2</sub> emission constrained environment. It is important that it be done.	Agree.
Early stage effort, not much results reviewed.	Presented project plan at merit review, project just started at time of merit review.
This is a good project.	Agree.
In order to not put all future generation options in one basket (IGCC) we need to explore the potential for a combustion pathway for both new and as a retrofit application.	Significant oxy-fuel retrofit studies have been performed by ALSTOM. Due to funding constraints and to prevent duplication of work, we chose to stick with greenfield installations.
You should also look at other oxy combustion work.	Studies by ALSTOM, Foster Wheeler and IEA GHG association were researched and results from these studies were used to frame the NETL study.
Much needed analyses to look at alternative paths to zero emission.	Agree.

**Project Title:** D2. Alternate Approaches for Hydrogen Economy  
**Presenter:** Pete Balash  
**Overall Rating:** 2.60 (Good)

**Project Abstract:** The purpose of this project is to transform Presidential objectives for reducing petroleum consumption and carbon emissions by 2040 into scenarios for use in an economic model and conduct a high-level economic analysis of technology and the “hydrogen economy” by integrating rigorous engineering cost estimates with a macroeconomic model. Coal-fuels substitution and efficient vehicles meet Presidential reduction goals. Support for modeling includes development of the MARS (macro analysis of petroleum refinery systems) model and coal power/Fischer-Tropsch fuels co-production system to derive economic threshold and initial location of carbon capture. Accomplishments include completion of a working prototype refinery forecasting model and interfacing with the AMIGA model for economy-wide analysis. A significant portion of the effort has been for scenario development. Future work includes providing support to DOE hydrogen economy modeling led by EE with interest in refinery modeling and coal comparisons. Peer review publications will result. Model documentation and future NETL/ANL cooperation is planned.

Reviewer Comments	NETL Response
I am not sure how well this work supports the program.	It promotes advanced coal technologies and lends scope to possible future market share for advanced coal power, coal-to-liquids, and coal-to-hydrogen technologies. Further, refinery modeling capability has been developed, necessary for modeling downstream petroleum application and the overlap between alternative fuels and petroleum.
This project supports the President’s stated goals for petroleum reduction and CO <sub>2</sub> emissions reduction.	Agree.
This work quite reasonably supports the program, although the study is restricted to just two of many options 1) fuel efficient vehicles, and 2) CTL. Some people might object to the exclusion of biomass, shale oil, and EOR.	Nuance: An outcome of the exercise is an increase in renewable power generation in both scenarios. EOR and other recovery techniques are point of the ‘noise’. Agree with comment on biomass and shale oil. A more comprehensive extension could look at these options.
This analysis appears to support EE program goals and objectives.	1) Coal technologies play an optimizing role in both scenarios, whether through coal to liquids, coal to hydrogen, or both. These technologies are FE program related. 2) FE is clearly in a support role to EE in all hydrogen-economy related programs and activities. This scenario project is part of that support.
Provides broad information on pathways to achieve energy security that have implications for research and development.	Agree.
The issues being addressed appear to be	Thank you.

clearly defined.	
Well done regarding key challenges.	Thank you.
This is a forecast and is difficult to accurately predict the future.	Agree.
Scenarios are complicated and assumptions are difficult to make.	Agree.
Significant challenges are understood.	Agree.
An important constraint has not been included in the study – the peaking of world oil production. It is certain that peaking will occur by 2040. I understand that it would be politically difficult to include peaking, but without peaking, the study is of only of abstract value. The selection of oil price for the study is also very tricky. While \$37 in 2010 may appear in some references, it is surely wrong. A range of oil prices would be more appropriate.	A variant of peak oil is being handled as a sensitivity. Higher oil prices will result. As for prices in the current scenarios, it is important to grasp that, along with the imposed fuel and carbon charges, effective oil prices reach \$60. If, in real time, oil prices remain in the \$50-\$70 range, then transformations will occur without resort to carbon and fuels charges.
The policy issues have been identified and some challenges are addressed.	Agree.
Challenges are somewhat clear; appear to resolve around developing modeling capability.	Well, to some degree. No degree of modeling capability can invent technologies that don't exist (i.e., cheap H <sub>2</sub> FCVs with range and storage) which is why that scenario had to assume tech breakthroughs, unfortunately.
Lead has command of literature and analysis techniques.	Thank you.
Approach is coherent.	Thank you.
Make assumptions and move forward.	Agree.
It is difficult to judge approach.	No comment.
International supply and demand impacts are hard to predict.	Agree.
The approach is quite reasonable. I was glad to see the use of models other than NEMS, which would be arguably of much lower value for these purposes. Benchmarking to AEO2005 is reasonable, however.	Thank you.
See comment above on peak oil and oil prices. The value of the work without peaking and much higher oil prices is open to question.	Agree that a constrained oil supply situation is desirable. Current results do imply, however, that if scenario assumptions occurred, peak oil after 2025 will be rendered less relevant as US consumption will have begun downward trend.
I urge the development of a peak oil case or at least a case with very high oil prices, say \$100-200/bbl.	For peak oil sensitivity, supply is being fixed, rather than price. Sustaining prices over \$100 for the entire study period seems implausible, as draconian conservation and supply-side alternatives would have been developed, leading to a collapse in the

	demand for petroleum, and its price.
Command of literature and analysis techniques appears to be very good.	Thank you.
Approach seems appropriate.	Thanks.
Communication was effective.	Thanks.
The scenarios discussed seem appropriate	Thanks.
Again this is a forecast, hard to judge the validity of the predictions. However, the results are indicative of what would happen if the assumptions are correct. Not sure if the supply and demand scenario includes overseas growth in countries such as India and China that might impact future oil and NG prices.	Point well taken. The scenarios are US-centric. Reference case oil prices imply needed supply found and developed, a questionable assumption today. However, without employing world oil trade model, with accompanying income and price elasticities, I would find it difficult to model the emergence of Asian demand beyond a generally higher assumed world oil price.
The results are open to very large question because of the issues raised above. The value as the study is currently configured will be low.	No comment.
It appears the critical issues were addressed.	Thank you.
Results appear reasonable and have been distributed.	Agree.
Analysis of the results was clear.	Agree.
Plans for future are appropriate.	Agree.
Alternate cases need to be considered.	Agree.
Plans appear to be appropriate.	Agree.
Less relevant to directing research and development programs than other types of process modeling.	Perhaps not as direct. Results argue for high-level support for CTL and Coal to H <sub>2</sub> and Capture and Sequestration research. Additionally, “clean” Naphtha, whether from petroleum or coal feedstocks, should be considered as a hydrogen carrier.
This work suggests that additional work on integrating additional coal utilization into refinery operations, beyond FT liquids production would be very useful. For example, the use of coal gasification for hydrogen production for product upgrading or feeding coal to cokers.	Agree.
Good to have the project start date to help in rating the project overall progress. This presentation has it.	OK.
Overall this is interesting work.	Thank you.
The study seems less relevant to defining research and development program direction than other technology system analysis studies.	No comment.