Technology Validation
Summary of Annual Merit Review Technology Validation Subprogram

Summary of Reviewer Comments on Technology Validation Subprogram:

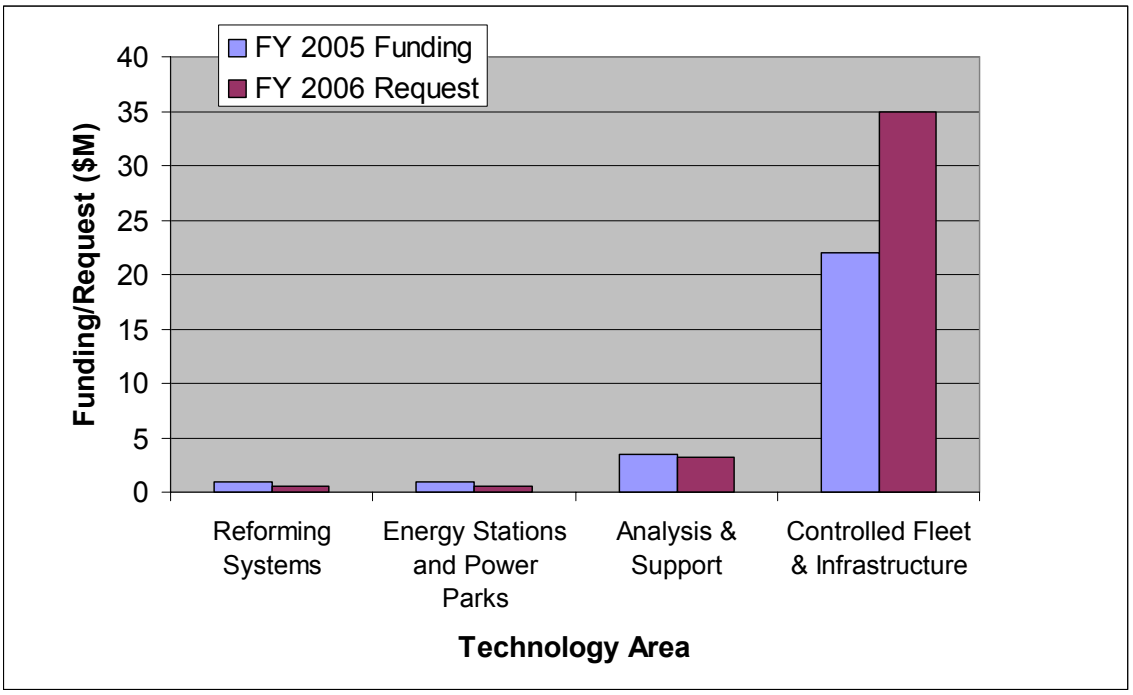
Reviewers identified the technology validation of key hydrogen energy technologies and systems to be an essential component of the Hydrogen Program mission and critical to the President's Hydrogen Fuel Initiative. The program results were seen as providing an important data base. The projects were considered to be appropriately diverse and strongly focused on addressing key targets of RD&D objectives across several options such as natural gas to hydrogen stations, power parks, energy stations, and learning demonstrations. Reviewers noted that the projects will collect a critical data base for the operation of fuel cell vehicles, delivery of hydrogen and the production of hydrogen and that the information dissemination will provide a confidence level for the public. The analysis efforts that supported the learning demonstrations and the power parks were seen as instrumental to DOE making program decisions. Both principal investigators of the analysis effort had a commendable appreciation of what data is needed and had successfully structured the means of getting it through cooperative participation.

Reviewers thought highly of the Technology Validation Subprogram's approach of conducting large ***learning demonstrations*** that emphasize co-developing hydrogen infrastructure in parallel with hydrogen fuel cell-powered vehicles. They felt it lends credibility and is of paramount importance to the research efforts and are vital to support a 2015 industry commercialization decision. Reviewers indicated that the California Highway Project (an earmark) should be placed in coordination with automotive OEMs and DOE's learning demonstration projects in the future. Technology validation of hydrogen energy systems that crosscut into all technology R&D subprograms is an important facet of the Hydrogen Program. As such, there is a need for strong coordination between these subprogram elements and a clear feedback loop to ensure that lessons learned are translated to next generation technology designs in the shortest possible timeframe. Reviewers also expressed the need that detailed project results, failure modes, root causes, etc. be fully shared with the rest of the program and in particular the Safety, Codes, and Standards Subprograms to ensure that safety and liability issues are sufficiently linked and adequately addressed. The reviewers also iterated that proof of economic viability is an important part of technology demonstration. The reviewers felt that power parks were a good demonstration of integrated systems for transportation, infrastructure and electric generation in real world operating conditions. There were concerns expressed about better focusing some of the efforts and the need to minimize some of the options being considered. There were diverse reviews of high temperature fuel cell energy stations. Some of the reviewers felt it was an important concept to future low-cost hydrogen production and a good transition concept, but one reviewer felt it was a re-invention of a 10-year-old government program with little new to offer and was proprietary to the team investigating the concept.

Congressionally directed projects received lower scores and had greater negative comments attributed to them than the competitively-selected projects. The previous year's comment by reviewers that felt that it would be important to have specific information on the project funding level and schedule of activities appear to have been addressed this year. However, there were significant critical comments expressed about assuring that the projects were addressing DOE targets, especially for Congressionally directed projects.

Technology Validation Funding by Technology:

The funding portfolio for Technology Validation addresses the need to validate integrated hydrogen and fuel cell technologies for transportation, infrastructure, and electric generation in a systems context under real-world operating conditions. The FY 2006 funding profile (subject to Congressional appropriation) addresses key aspects of the Hydrogen Program mission and the cross-cutting issues associated with the National Academies' Report and system integration activities.



Majority of Reviewer Comments and Recommendations:

In general, the Reviewer scores for the Technology Validation Subprogram were on average with those of the other subprograms (the maximum, minimum, and average scores for Technology Validation projects were 3.63, 2.32, and 2.87, respectively). These compare to the overall maximum, minimum and average project scores of 3.92, 1.55, and 2.91, respectively. The major recommendations for the Technology Validation Subprogram are summarized below. DOE will act on reviewer recommendations as appropriate for the overall Hydrogen Technology Validation effort.

- **Power Parks Analysis** – Focus on making available data public and be careful in some of the projects to focus efforts on meaningful technologies. Continue integrated system analysis in support of these projects and making economic projections.

- **Energy Station Demonstration/Analysis** – Could be a potentially attractive option for the low cost production of hydrogen. Be careful to use the best technology and not investing in mature proprietary systems.

- **Vehicle/Infrastructure Learning Demonstration** – Focus activities to ensure that lessons-learned become public information. Emphasize the dissemination of information to research and development program and the public. Continue analyses in support of these projects and secure data room to promote information collection and dissemination.

Project # TV-01: Technology Validation Sub-Program
Gronich, Sig; U.S. Department of Energy

Brief Summary of Sub-Program

The purpose of this Technology Validation Sub-program Overview is to describe goals/objectives, budgets, barriers/targets, approach to R&D, technical accomplishments, interactions and collaborations, solicitations and awards, and future directions. Projects in this sub-program area set the stage for providing a validation of the technology status and unique system configurations to meet cost and performance targets and an important feedback loop to manage the R&D programs.

Degree to which the Sub-Program area was adequately covered and/or summarized

- A very clear overview was presented with goals and targets.
- Very thorough.
- Covered all areas adequately.
- Excellent.
- Presentation very effectively and comprehensively covered all aspects of the Technology Validation activities.
- Excellent overview of sub-program describing breadth of activities.

Were important problem/issue areas and challenges identified/discussed, including plans for addressing these items in the future?

- Significant challenges were discussed, with plans and projects intended to address each.
- Some important issues were identified but it is not obvious that all significant issues are noted.
- Yes, very well.
- The tasks outlined are very well placed to supply operational, real-world duty cycle data that is essential for moving towards commercialization.
- Technical barriers were presented and described very well.

Does the Sub-Program area appear to be focused, managed well, and effective in addressing the Hydrogen Program R&D needs?

- The area is well-managed, with a project portfolio that addresses the goals and targets.
- Overall goals are focused but too many details were described about projects rather than putting them all in perspective.
- Yes, very well.
- The plans have been creditably formulated, and implementation is progressing on schedule.
- DOE management of this sub-program is limited by Congressional Directives, which generally are not supportive of the President's Hydrogen Initiative.

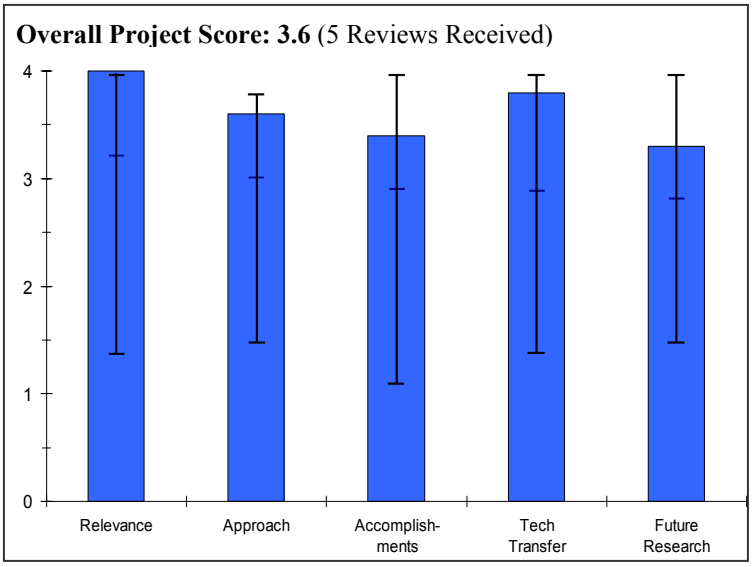
Other comments:

- Extremely well done. Very impressive.
- The Technology Validation Sub-Program is a much needed addition to DOE's hydrogen and fuel cell program.
- Subprogram objectives and plans are excellent, and DOE is doing a good job of integrating Congressional Directed activities.

Project # TV-02: DTE Energy Hydrogen Technology Park
Regan, Rob; DTE Energy

Brief Summary of Project

In this project, DTE Energy will develop and test a working prototype of a hydrogen-based power park concept that utilizes a combination of renewable and non-renewable power (including on-site solar) with electrolysis and stationary PEM fuel cell technology; the system will take advantage of low-cost power during off-peak hours to generate hydrogen for on-peak power generation and vehicle fueling. Using state-of-the-art hydrogen generation, storage, regeneration and control technologies, the project will evaluate opportunities to reduce overall system cost and maximize performance.



Question 1: Relevance to overall DOE objectives

This project earned a score of **4.0** for its relevance to DOE objectives.

- Technical and safety issues were properly addressed.
- Results align fully with DOE targets.
- PI must consider analyzing economic aspects of co-production in more depth, like as estimated cost for end consumer.
- Excellent demo of integrated system for transportation, infrastructure, and electric generation to be operated in real-world operating conditions.
- Directly applicable.
- Project is aligned with multiple HFCIT program goals.
- Involvement of utility company in HFCIT power park technology validation is highly appropriate.
- Program addresses key targets of RD&D objectives and demonstrations will be critical to realization of the President's Hydrogen Fuel Initiative.

Question 2: Approach to performing the research and development

This project was rated **3.6** on its approach.

- Barrier C was not fully addressed, as the project has not investigated hydrogen and fuel cell electricity costs.
- The solar power system appears to be of little value to the demo.
- Looks highly focused.
- Ambitious integration of many elements.
- Program systematically addresses key technical objectives.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.4** based on accomplishments.

- Very good results were found.
- Technical weaknesses were fully mitigated.
- Electrolyzer not yet operational.

- Good progress, next year should yield a lot of data.
- Getting this multi-element project operating was a significant accomplishment.
- Presentation should include more specific operating data examples.
- Program has successfully met or is aggressively addressing objectives in an organized and methodical fashion.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.8** for technology transfer and collaboration.

- The participation and the role of each partner was fully explained.
- Excellent team with tie to vehicle validations.
- Expanded participants.
- Project should emphasize near-term transmittal of specific operating data to other HFCIT program activities.
- Program data has been published repeatedly in last year.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.3** for proposed future work.

- Future work seems correct and coherent with whole project targets.
- PI to consider including economic aspects, mainly hydrogen and electricity production costs.
- Next phase should yield a lot of good data.
- Plans should increase emphasis on data generation and sharing.
- Goals consistent with meeting program objectives.

Strengths and weaknesses

Strengths
- Very useful demo project with excellent team.
- Use of commercially-available hardware. Good collaboration with partners.
- Multi-element project will provide early technology validation data.
- Utility company involvement and perspective is valuable.

Weaknesses
- Solar power system appears to add little value to the project.
- Geographic location not ideal for renewable resources.
- Needs more emphasis on data sharing.

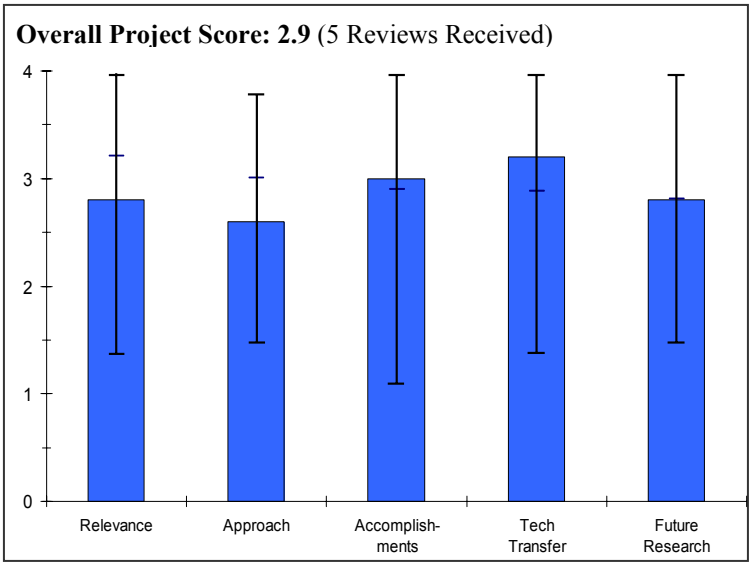
Specific recommendations and additions or deletions to the work scope

- Include hydrogen and electricity production cost estimation.
- None.
- Ensure that specific quantitative operating data will be published and available to all legitimate researchers (not just SNL).
- This program appears near completion. Support of controlled fleet should be continued but does not appear to be a major effort.

Project # TV-03: Hawaii Hydrogen Center for Development and Deployment of Distributed Energy Systems
Rocheleau, Richard; Hawaii Natural Energy Institute

Brief Summary of Project

On this project Hawaii Natural Energy Institute (HNEI) will develop and operate a test bed for validation and characterization of hydrogen technologies in a real world setting; characterize the effect of trace level contaminants on the performance and durability of PEM fuel cells; develop novel multi-terminal device configurations which offer potential for higher efficiency photoelectrodes for solar hydrogen production than achievable with current thin film approaches; and investigate critical steps for hydrogen production from biomass, including biomass and syngas conditioning/cleanup, optimal pathway assessment, and characterization of selected biomass gasification technology.



Question 1: Relevance to overall DOE objectives

This project earned a score of **2.8** for its relevance to DOE objectives.

- The project aims to validate different technologies, which is going to help DOE to decide between alternative approaches for the hydrogen economy.
- Comprehensive systems.
- Targets/goals not clearly described or quantified.
- All elements are relevant but effort is dispersed.
- Addresses HFCIT program objectives.

Question 2: Approach to performing the research and development

This project was rated **2.6** on its approach.

- An approach for cost analysis should be considered.
- An approach for comparison between technologies, including cost, performance and best niches for utilization should be considered.
- Leverage DOD investment and data collection, with intensive guidance from industry.
- This project is a set of four largely unrelated efforts, none of which appear to be unique or add much value for the program.
- Individual areas seem focused but they are too diverse i.e., 4 projects. Some projects seem to get too detailed i.e., evaluate MEA's rather than just keep to fuel cell systems.
- Good leveraging of funding.
- PI did not explain if or how the four project elements are integrated.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.0** based on accomplishments.

- Many good results were achieved.
- PI responded adequately to previous year comments.

- Data reproducible.
- Largely some simple tests of commercial equipment.
- Good progress. Needs more data generation.
- Good progress considering delay challenges.
- PI should present more explicit planned vs. actual accomplishments schedule.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.2** for technology transfer and collaboration.

- The transfer of protocols for fuel cell building, operation and testing will improve the quality of results.
- Working with small business.
- Several partners were indicated, with unclear roles for some.
- Good collaboration with many others. Good leverage of other efforts i.e., DOD and State.
- Excellent example of early data generation and open data dissemination.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.8** for proposed future work.

- Recommended modifications were fully addressed.
- Inclusive approach.
- Goals/objectives are unclear.
- It is a logical progression but should be narrowed to concentrate on fewer projects.
- Plan is basically to overcome challenges and to continue work on four relatively unrelated sub-projects.

Strengths and weaknesses

Strengths
- Transfer of fuel cell manufacturer's protocols. Hard to negotiate with them and very important for technology validation.
- Diversity of hydrogen production technology is a strength if the results can be compared and indicate best utilization of each one.
- Responsive to last year's peer review.
- Good natural renewable resources. Good collaboration with others. Central point for several organizations.
- Excellent initial data generation and dissemination.

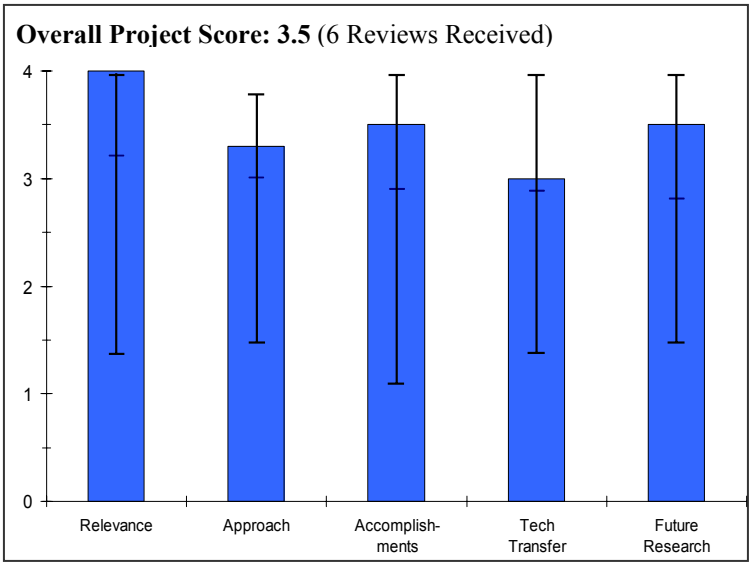
Weaknesses
- Diversity of hydrogen production technology demands significant project management resources and can delay activities.
- Requires a lot of management.
- Diverse set of projects without clear and quantified goals and objectives.
- Don't have a lot of fuel cell construction technology experience required for fuel quality evaluation.
- Overall project appears to be composite of four relatively separate sub-projects.

Specific recommendations and additions or deletions to the work scope

- Include cost analysis approach.
- Include approach comparison between different technologies.
- Continue project- good value.
- Do not fund this project.
- Suggest deletion of biomass effort. Suggest focus fuel quality effort on overall system not cell or cell element.
- Continue as planned and consider dropping a sub-project if funds are needed for completion of other sub-projects.

Project # TV-04: Hydrogen Power Park - Business Opportunities Concept Project
Hobbs, Raymond; Pinnacle West Capital Corporation

Brief Summary of Project



In this project, Pinnacle West Capital Corporation conducted field testing of several hydrogen power park components including electrolytic production systems, compressors, and dispensers; photovoltaic energy supply systems; hydrogen ICE engine generator sets; fuel cell generators; and hydrogen ICE vehicles. Results of these tests are being utilized to evaluate the economics of four hydrogen power park configurations. Aspects of these configurations include hydrogen production, renewable energy opportunities, integration of distributed generation and transportation fuel production, incorporation with existing energy assets, scalability, and integrated business opportunities. Analyses will identify technical barriers and market opportunities for each hydrogen power park configuration.

Question 1: Relevance to overall DOE objectives

This project earned a score of **4.0** for its relevance to DOE objectives.

- The project aims to validate different technologies, which is going to help DOE to decide between alternative approaches for hydrogen economy.
- The project aims to use local renewable energy sources.
- Find value proposition in the real world.
- Excellent technology validation with real-world operating conditions.
- Excellent facility with real results.
- Project addresses multiple HFCIT program objectives.
- Utility company involvement is highly appropriate.
- Program addresses key targets of RD&D objectives and supports the President's Hydrogen Fuel Initiative.

Question 2: Approach to performing the research and development

This project was rated **3.3** on its approach.

- Cost analysis was done.
- Analysis using utility techniques very comprehensive. APS demonstrated an ability to effectively engineer power park components and put the unedited info on the web.
- Size of equipment is small but a good first step.
- Some of the project components do not relate directly to the HFCIT program mission.
- Project work appears to be executed very carefully.
- Approach establishes models for a power park and then compares the models to real experience in operating a power park.
- It is not clear that models will be valid for other locations and a means to test models for different climates should be developed.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.5** based on accomplishments.

- Good cost analysis.
- Project results address DOE cost targets even if not achieving efficiency target.
- DOE has to analyze if previous result impacts global DOE targets.
- Successful operation.
- Good accomplishments relative to DOE funds consumed.
- Difficult to understand the energy cost to produce hydrogen. Only energy cost reported. No capital or installation cost included.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.0** for technology transfer and collaboration.

- PI has not shown partnerships.
- If there are partners, PI must show them and explain role and coordination.
- If there aren't PI must consider including FC and equipment manufacturers, and also other partners, like the community.
- Regulatory: the hydrogen station is in an historic building which shows great collaboration with local officials.
- Should expand promotion and exposure to public nationally.
- Valuable real-world data being generated.
- Perhaps raw performance data dissemination should be increased.
- Important to clearly state conditions/assumptions when announcing general conclusions from project.
- Collaborating with large group.
- Did not see references to publications.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.5** for proposed future work.

- Other hydrogen sources addressed.
- Continue because APS provides hydrogen fuel at posted prices to the public at gge economics- a powerful example for other utilities.
- Future plans are too broad if they expand to include biomass, bromine cells, and Mobile facility.
- Appears to be essentially "keep on doing the same".
- Expanding efforts to include other technologies appears valuable.

Strengths and weaknesses

Strengths
- Different hydrogen sources.
- Cost analysis.
- Safety. Availability, 26K hours of calendar operation. Great data that is very transparent.
- Useful demonstration project with real-world operating conditions.
- Good commercial experiences.
- Important power park technology validation project.
- Provides beneficial utility company involvement and perspective.

Weaknesses
- Lack of partnerships.
- Didn’t include all data analysis, i.e. didn’t include capital costs of fuel cells.
- Some project elements are not specific to HFCIT program mission.

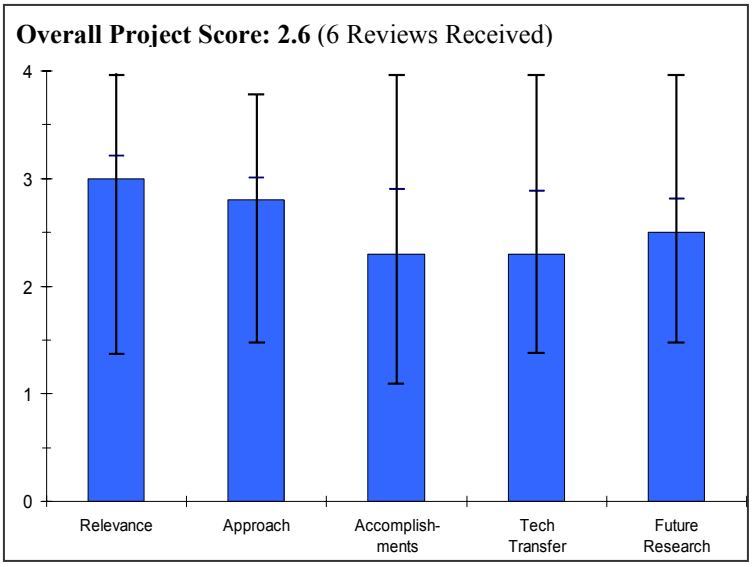
Specific recommendations and additions or deletions to the work scope

- Include cost reduction strategy, mainly for PV based hydrogen production.
- Must continue. Replace electrolyzer. Replace fuel cell.
- Continue as planned.
- Ensure that basic performance data as well as overall conclusions are broadly disseminated.
- Need a better explanation on energy cost to produce hydrogen using electrolysis from grid.
- Care should be taken with Bromine cell for future work; hazardous material.

Project # TV-05: Validation of an Integrated System for a Hydrogen-Fueled Power Park
Keenan, Greg; Air Products and Chemicals, Inc.

Brief Summary of Project

Air Products and Chemicals, Inc. (APCI) is conducting a project to demonstrate the technical and economic viability of a hydrogen energy station using a high-temperature fuel cell to produce hydrogen and electricity. They will optimize the system for lowest total energy cost, and develop a cost estimate to demonstrate a prototype natural gas based energy station at a suitable site. Safety will be the top priority in the system design and operation.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.0** for its relevance to DOE objectives.

- Using high temp fuel cell seems like political positioning. Copies the work of many fuel cell firms.
- Useful tech validation project using high-temperature fuel cell. Clear relevance to DOE targets.
- Goals seem marginal with only 10% hydrogen recovery. Low efficiency improvements.
- Producing low cost hydrogen may well entail the co-production of electricity, although there are many complexities in scheduling the co-products, regulation of electric supply, etc. This project addressed this important energy station option to future hydrogen supply.
- Program addresses operation of a molten carbonate fuel cell with off-gases going to hydrogen and utilizing heat for CHP type applications.
- Program seems better suited for Office of Fossil Energy and it is not clear why it is in this activity.

Question 2: Approach to performing the research and development

This project was rated **2.8** on its approach.

- Good and innovative solution for efficiency improvement.
- Simplistic. Relearned obvious information from past MCFC. Spent 2 years looking at PEM than switched to SOFC and /or MCFC using unclear criteria.
- Barriers are addressed in the presentation but the substance of the presentation doesn't flow from those barriers.
- This is a solid team.
- The molten carbonate fuel cell approach with the waste hydrogen it produces is an interesting option that deserves investigation.
- Approach does not supply details of how program would be applied. No indication of cost of installing CHP system, for example cost of chiller or ORD.
- Benefits described for program must be meant to justify the approach.
- Not clear that approach analyzes the balance of load demand, i.e. power, hydrogen or heat loads. The approach does not identify which load would be the primary design point.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.3** based on accomplishments.

- Most of demands made previous year were satisfactorily addressed.
- Lacks partnership detailing.
- Baloney! The numbers presented were theoretical and not bottoms up analytical- therefore simply repetitive of DOE publications. Two years to think about fuel cells is unacceptable.
- Phase 1 required. Too long for completion.
- Still early in the program.
- DOE cost goals are appropriately central to this project.
- If economically and operationally successful, this project will provide an important option for companies with electric and hydrogen co-production in their business plan.
- Results are presented but maybe not in a way that other companies and researchers can gain understandings that are likely to be useful to them. This is not unusual for a project still in the design stage.
- To operate with excess hydrogen at the anode, excess methane must be introduced to the MCFC. Because of internal reforming, the endothermic reforming of the excess hydrogen will cool the fuel cell and take it off of peak performance, possibly lowering the efficiency.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **2.3** for technology transfer and collaboration.

- Partnerships need to be detailed.
- Role of partners must be addressed.
- Molten carbonate is mature and overanalyzed: the chosen FuelCell Energy DFC-300 has been studied at length.
- There appears to have been little collaboration to date.
- This is not happening much yet, except for vendor involvement, but this technology transfer and collaboration is planned in Phase 3.
- Publication of interim results that would help others begin comparable projects should be considered.
- Presentations given but could not find whom collaboration was with.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.5** for proposed future work.

- Activities seem reasonable, but PI needs to detail the targets and confidence level in achieving them.
- Desire more tax dollars to incrementally improve hardware that is protected by FCE. Not worthy of continuation.
- Seems like we need to focus on fuel cell output first, then a secondary issue such as hydrogen recovery.
- This project has a high probability of technical success.
- The results need to indicate whether this is an economically-viable approach to hydrogen production in the long term.
- Engineering analysis is critical for this project. This should be major function before design work is completed.

Strengths and weaknesses

Strengths

- Technical solution for co-production is innovative and can strengthen technology deployment.
- Was honest enough to admit this was not an original idea.
- Very useful technology validation project.
- Good expertise in gas processing.
- This is a strong project team and addresses the need to better understand the potential for this method (molten carbonate fuel cell) of co-production of electricity and hydrogen in distributed settings.

Weaknesses

- None of importance in context of the activities of competent fuel cell manufacturers and integrators. An empty project in terms of benefits to hydrogen community. Re-invention of molten carbonate fuel cell system that was fully described and analyzed using government funds over 10 years ago. This program is a great example of selling a used concept that belongs in the realm of industry. The program benefits no one but APCI and FCE, which own the patents to commercialize this system. (Arrogant position on sharing information.)
- Project has had a slow start, with an excessive length of time spent on phase 1.
- Marginal advantages for this process.
- Communication of more results to project developers, even at this early stage, would be useful.

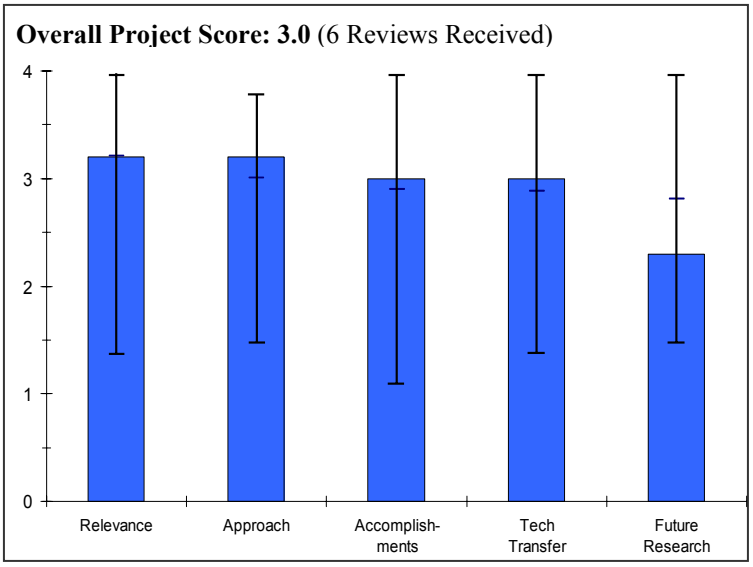
Specific recommendations and additions or deletions to the work scope

- Detailing of partnership and future work.
- Immediate cancellation is most appropriate. Public condemnation as waste and abuse of DOE funds. This is a blatant attempt to use government money for incremental product/system improvements to the sale benefit of APCI and FCE.
- Concentrate on each element i.e. FC and purifier.
- Since design and operation will need to evaluate the dispatch and role of the separate outputs (electricity and hydrogen, and heat), insight into this analysis and the results for future project developers will be important.
- Recommend independent team evaluate the energy and mass balance of this system and additional capital cost for CHP and hydrogen collection/storage prior to further design or construction of system.

Project # TV-06: Novel Compression and Fueling Apparatus to Meet Hydrogen Vehicle Range Requirements
Carlson, Todd; Air Products and Chemicals, Inc.

Brief Summary of Project

The objective of this project by Air Products and Chemicals, Inc. (APCI) is to develop a novel compression and fueling apparatus to meet hydrogen vehicle range requirements. An isothermal compressor concept was designed, simulated and tested. High pressure automatic valves, 900 bar storage valves for cascade, flow meter, dispensing equipment and other instruments were also investigated for achieving this objective.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.2** for its relevance to DOE objectives.

- Time for fueling hydrogen into vehicles is an important barrier to be overcome.
- Improved compression efficiency and lower cost are important considerations in hydrogen systems.
- This narrowly defined project can potentially provide incremental benefits for a small portion of a "hydrogen economy."
- Hydrogen compression is important -- 1000 psig.
- Very relevant to hydrogen program, with significant potential benefits if successful.
- The advantages of this design are not obvious. While novel, alternatives are available.
- Improving the economics of hydrogen pumped into a vehicle tank is critical; the goal of this project is critical.
- This project is important for exploring better ways to produce high pressure hydrogen.

Question 2: Approach to performing the research and development

This project was rated **3.2** on its approach.

- Barrier is very specific and the project is well focused.
- Design issues to be addressed, for compressor and fueling stations, have been identified.
- The approach is somewhat determined/limited by what the auto industry will accept, e.g., in range.
- In third year of project. Clear focus on high pressure. Tied to hydrogen fueling station business expansion.
- Focus on making a compressor that has large advantages over conventional compressor, i.e., cheaper and more efficient.
- The compressor approach is innovative and creative.
- This project recognizes the roles of codes and standards and their incomplete development, and possible codes and standards development too early for the results of this project.
- The relationships between the project approaches taken and cost goals are not articulated.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.0** based on accomplishments.

- Problem analysis was adequately addressed.
- Pressure analysis indicates the need for hydrogen cooling, which can be a problem for fuel costs and safety.
- PI must indicate feasibility more clearly.
- New valves and pressure switches have been developed.

- Isothermal and single stage design objectives have mostly been achieved.
- Information on the cost baseline that progress is being measured against was not included in the PI's presentation.
- 700 bar target established by car firms. Competent in technology.
- The proof will be when the unit is assembled and tested.
- Technical accomplishments are well presented at the high level necessary in this meeting.
- Analysis and design details for future projects would be expected in a more detailed report.
- The expected efficiency and cost results should be provided.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.0** for technology transfer and collaboration.

- Partners were not shown.
- If there aren't partners, PI must consider the need of them and explain if they are not needed.
- A number of collaborating companies on this project.
- Meaningless list of component suppliers that have all signed NDA's with APCI is misrepresentation of "collaborations."
- Excellent project team.
- Should get a compressor manufacturer involved.
- The presentation explained a lot of the decisions made and the technology selections.
- Conveying this initial analysis and design information in a way that others following in their tracks can understand will be important.
- The role of auto manufacturers in determining storage pressure presents interesting issues that were discussed.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.3** for proposed future work.

- Next steps are quite adequate.
- PI must detail tasks and indicate technical targets and solutions.
- Future work touched on only briefly.
- No indication of costs for future work.
- Assemble and test, case determination, marketing, and T&E for warranty all valid. Taxpayer support for their marketing effort is inappropriate. That cost element should be isolated and eliminated.
- Limited discussion of issues that might be encountered during remaining steps was presented.

Strengths and weaknesses

Strengths
- Focused project aiming to solve specific and important technical barrier.
- Technologically competent staff.
- Very relevant technology validation project with significant potential benefits.
- Broad experience with other fueling station activities. Broad experience with handling high pressure hydrogen.
- The safety considerations and experience are possibly the best of the projects.
- Air Products knows compressor technology very well and is using it in this project.
- This presentation was outstanding.

Weaknesses
- Part of presentation devoted to review of Air Products hydrogen history/experience. Not relevant for project review.
- In regards to compressors, there are several competent suppliers, most of which would not obviously agree to APCI's proprietary rules and market defense strategy. It is beyond reason for DOE to support this project to help APCI become vertically integrated to the detriment of many smaller businesses.

- No major technological advantages noted.
- There is not much to complain about.
- Tighter linkages between approaches taken and cost goals would help share understanding to future users of this information.

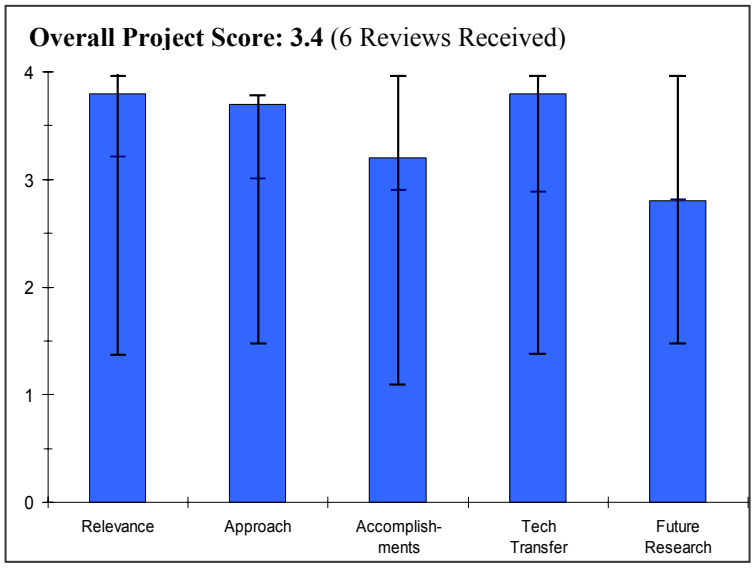
Specific recommendations and additions or deletions to the work scope

- Details and addressing of technical challenges are needed.
- More confidence on technical feasibility is needed. Suggest a risk analysis of target achievement be conducted.
- APCI should be clearly directed to share the vendor development info with other stakeholders.
- Suggest close evaluation of final test results before continuation.
- None.

Project # TV-07: Controlled Hydrogen Fleet & Infrastructure Analysis
Wipke, Keith; National Renewable Energy Laboratory

Brief Summary of Project

Under this multi-year validation project the National Renewable Energy Laboratory will assist DOE in demonstrating the use of fuel cell vehicles and H2 infrastructure under real-world conditions, using multiple sites, varying climates, and a variety of sources for hydrogen, including renewables. The primary activities over the last year were to develop data templates for fuel cell vehicle and infrastructure data, and then establish a Hydrogen Secure Data Center to store and analyze this highly sensitive data. Initial vehicle data has been received and analysis procedures are being developed. Future activities will include analyzing the data to obtain maximum value for DOE and industry from this "learning demonstration," feeding back key non-proprietary findings into the HFCIT program R&D activities.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.8** for its relevance to DOE objectives.

- Centralization of data from demonstration projects will be very helpful to DOE making go/no go decisions
- Project provides key support for, and credibility of, large validation projects that are vital to eventual commercialization.
- Hydrogen Secure Data Center seems a good idea to break through the sharing barrier.
- A cornerstone project.
- The value of providing 'real world' data analysis is of paramount importance as a feedback loop to DOE's programs.
- It is necessary for the government to perform validation of technologies to determine if the Program is on track to succeed.
- This validation in itself is not R&D, at best; it will verify that the targets have been met.

Question 2: Approach to performing the research and development

This project was rated **3.7** on its approach.

- Project will allow high level system analysis.
- Data management is well addressed.
- Note: Not R&D.
- Design and establish system for acquiring, analyzing and securing industry data.
- Approach has resulted in successfully negotiating agreements with validation contractors.
- Takes advantage of prior analytical tools and NREL working relations with industry.
- Comprehensive data collection. Template for providing data and analysis.
- All key players are involved.
- Range of topics and aspects well covered.
- The PI has a commendable appreciation of what data is needed and has successfully structured the means of getting it through cooperative participation.

- This project will not contribute to overcoming the barriers, but it appears that data is being gathered to track progress on most of the barriers and will provide feedback on technology shortfalls.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.2** based on accomplishments.

- Explanation on timeline is not clear. PI has mentioned start at FY03 and project being 15% complete, but timeline starts Feb 7th 2005.
- For this timeline (Feb 2005) addressed accomplishments seem adequate, but for a project starting on 2003 results seem too modest.
- Created data templates and got approval by teams.
- Established Hydrogen Secure Data Center at NREL.
- Gained agreements from industry on data handling and security.
- Legalities of data transfer. Automation of statistical analysis. This project could move faster by using concurrent tests.
- Methodology is very good.
- Need to maximize data sharing.
- Getting the NREL Secure Hydrogen Data Center in place was and important achievement. Hopefully the data received will truly 'raw' and not in any way 'messaged'.
- Achieving agreement on data to be collected and reported is significant.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.8** for technology transfer and collaboration.

- Interaction with partners was well addressed.
- PI has demonstrated partner's role and cooperation on project.
- Must consider strategy to use data analysis to find solutions to development barriers faced by the partners.
- Commendable collaboration, interaction, negotiation with companies on validation teams.
- Project implementation included participation in California hydrogen activities.
- Very narrow. Seems non-applicable.
- Need effort to provide public relations story to public to sell hydrogen safety.
- Full participation has been ensured by this well planned venture.
- Certainly a good representation of industry partnering in this project.
- It is not clear that technology shortfalls will be communicated to other research institutions in a way that those institutions can assist is solving the problems.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.8** for proposed future work.

- It is missing a mechanism to measure impact of data analysis on technology development (e.g.: how useful data analysis will be for reduction of hydrogen price per mile).
- Work to be done in years following FY 2005 is stated in general terms.
- Must stay independent and report the bad and the good.
- This project will be of outstanding interest and value over the next year.
- Go/no-go milestone criteria must be quantified.

Strengths and weaknesses

Strengths
- Ability to work constructively with validation teams to acquire data that will be important to future hydrogen program direction, and which is in the public interest.
- Ability to make agreements with team's lawyers. Answered last year's reviewer's comments.
- Well planned and operated.
- Great analysis capability planned.
- Great coordination, planning and implementation.
- Achieving agreement with manufacturers to make public composite data available to DOE and the public.

Weaknesses
- Lack of clarity of how the HSDC assures a meaningful data sharing with stakeholders.
- None.
- None evident.
- Lack of plan/process to provide technology shortfall information to research institutions.

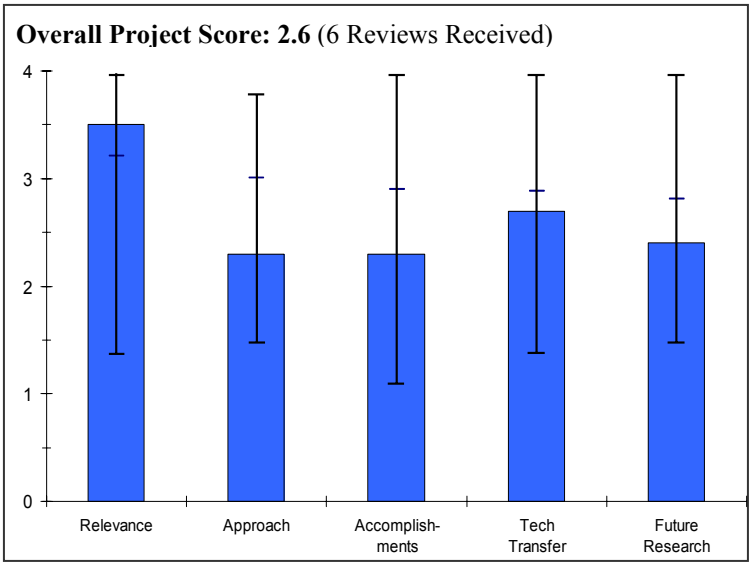
Specific recommendations and additions or deletions to the work scope

- To develop mechanisms for measuring impact of data compilation and analysis on technology development.
- To develop mechanisms for identification of solutions available in academia or national research centers.
- Safety confidence from aggregate experience should be prioritized as a communications product(s).
- Leave an entry opportunity for the small entrepreneur who may contribute new key technology unexpectedly.
- Ensure, to the extent possible, that both the data received, and its subsequent analysis remains 'spin-free' of stakeholder influence.
- Establish a plan for providing technology shortfall information to research institutions in a form that will permit them to propose projects that will lead to solutions.
- Establish quantified criteria for Go/No-Go decision milestones.

Project # TV-08: California Hydrogen Infrastructure Project
Pedersen, Mark; Air Products and Chemicals, Inc.

Brief Summary of Project

This project is focused on demonstrating a variety of flexible real world hydrogen fueling stations within California for use by fuel cell and internal combustion engine light-duty vehicles. The project will be performed with the support of state agencies, several automobile manufacturers and energy companies. The stations will offer various cost-effective infrastructure models that may lead to potential pathways in a fully developed hydrogen economy.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- Better definition of hydrogen infrastructure costs is important.
- Project needs more planning to realize the potential benefits for DOE's goals and to get the full value from the significant expenditure involved.
- None.
- This project directly addresses the DOE cost goal of lowering fueling costs.
- The project explores a variety of fueling options which should yield cost results across the spectrum for different fueling options.
- Availability of affordable hydrogen is a critical factor in the commercialization of FCV's. This project should indicate what is possible.
- Project is focused on one of the important parts of the DOE program, which is hydrogen infrastructure costs and availability.
- Attacking delivered hydrogen cost is probably the most important activity an organization could undertake.

Question 2: Approach to performing the research and development

This project was rated **2.3** on its approach.

- Will document a number of infrastructure technologies, in terms of performance, but project evidently does not include efforts to improve or optimize alternative approaches to delivering hydrogen.
- Variety of fueling approaches will be covered, as will variable climate conditions.
- Total of 14 separate sub-projects. Work needs to be done on how best to compare results among them.
- A data acquisition program being established.
- Not clear just what is expected to be learned. More defined detail in expectations is needed.
- The project approach presents an array of items (14 projects) being explored without clear focus or explanation of the interrelationships.
- It is not clear how the project approaches will actually reduce costs.
- Good coverage of the different hydrogen supply options available for vehicle refueling stations.
- The objectives slide states "we will gather infrastructure and fueling experience data as input to an infrastructure recommendation," but the data to be collected is not defined and an approach to making the recommendation is not clear.

- Data should be provided to Secure Hydrogen Data Center to be compared to infrastructure from learning demonstration.
- Approach is focused more on data collection and tradeoff studies rather than research to reduce hydrogen delivery cost.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.3** based on accomplishments.

- Project work not yet underway.
- Milestones for FY 05 and 06 are very general. e.g., one says only "150 hydrogen fueling stations in Southern California."
- None.
- This project has not begun yet.
- Early days yet.
- New project, so accomplishments not expected yet.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **2.7** for technology transfer and collaboration.

- Air Products is lead. Many "big name" collaborators.
- It is anticipated that there will be extensive cooperation/involvement of collaborators, but that topic was not covered in PI's presentation.
- Cost reduction opportunities should be highlighted as a "tech transfer" item.
- Included is a strong list of collaborators which helps with the technology transfer.
- Collaboration with National Center for Fuel Cells at UC-Irvine is a plus for the analysis planned, although UC-Davis may have more expertise on fueling options.
- Most of the major players are signed up.
- Nature of collaboration and interaction with auto companies not clear.
- How is placement of stations relative to vehicles decided?
- How will placement of refueling stations be done so that they are not too close to learning demonstration stations?
- No stated plans.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.4** for proposed future work.

- Information provided was so general that effectiveness of planning could not be determined.
- In response to question, PI said that more detail on objectives and milestones are in planning documents currently provided to DOE.
- Results expected are very general. Need details.
- Because the project has not yet begun, it is unfair to rank this item.
- Details of future work are somewhat sparse.
- Proposed Program schedule confusing. Rather than spanning 3 text slides, try doing it in a Gantt chart.
- Good plan for establishing many refueling stations with multiple delivery options, but it is not clear what new technology and research is entering into this project to reduce the barriers.

Strengths and weaknesses

Strengths
- Great plan. Will learn a lot.
- The company, team and collaborators are very strong.
- The variety of fueling approaches is a real plus and this lead contractor has the experience to do this work.
- Air Products knows this business.
- A strength of the project is that it focuses on an important DOE barrier.
- Strong emphasis on refueling.

Weaknesses
- Based on information provided, project planning to date is sketchy, limited.
- More clarity is needed on projected benefits/value added by this project.
- Expectation of learning to be gained not adequately defined in detail.
- Cost reduction opportunities identification should be first priority.
- The details and coordination among the 14 projects are not well documented, probably because the project hasn't started.
- Needs more focus.
- A weakness of the project is that it does not seem well planned or coordinated with either the four learning demonstration projects or the OEM vehicle rollouts in California.
- Not clear how project will continue to be able to collect/provide data once first year funding runs out.
- Very poorly defined plan.

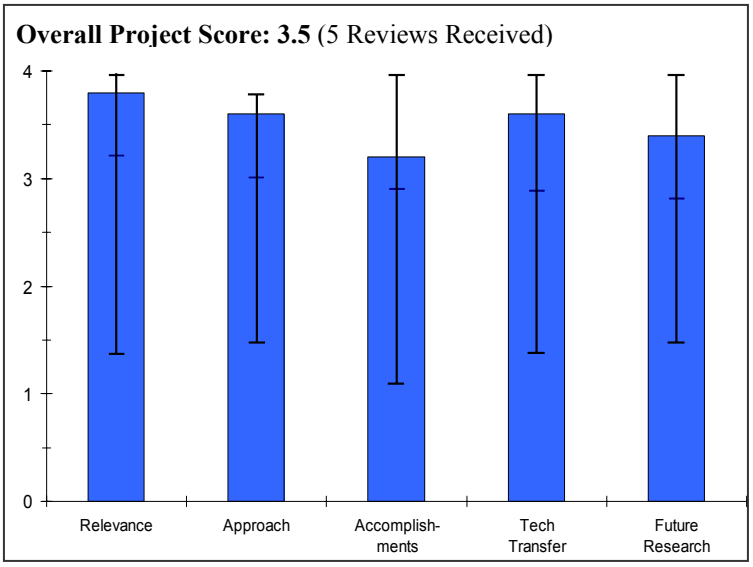
Specific recommendations and additions or deletions to the work scope

- Should add a project element that establishes communication, integration between this project and other California hydrogen initiatives, particularly those funded by DOE.
- None.
- Develop a work plan that links the multiple projects with goals and expected outcomes.
- For this large of a project ($10M) more emphasis should be placed on coordination with automotive OEMs and DOE's learning demonstration projects for the future.
- Unless a research, development and validation plan can be put together that fits with the DOE Program, this project should not be started.

Project # TV-09: Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project
BonHoff, Klaus; DaimlerChrysler

Brief Summary of Project

Through the DOE program, DaimlerChrysler will place more fuel cell vehicles in the hands of customers who can give valuable feedback about performance under different conditions. As the energy partner of the program, BP recently opened the first public hydrogen refueling station in Southfield, Michigan with DTE Energy Company. Another station was opened in a cooperative effort between BP and Praxair at the Los Angeles International Airport. DaimlerChrysler will test the vehicles in diverse environments in the United States. Varying weather, traffic conditions and driving style in each location will benefit the development of the fuel cell automobile and how it will be refueled.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.8** for its relevance to DOE objectives.

- Of paramount relevance to DOE's fuel cell vehicle programs.
- Program results should provide important database for operation of fuel cell vehicles, delivery of hydrogen, and production of hydrogen.
- Program should provide critical safety / hazards database.
- Database collection and dissemination will provide confidence level for public.
- It is critical to understand the performance of vehicles in real world conditions.

Question 2: Approach to performing the research and development

This project was rated **3.6** on its approach.

- Great plan- well thought out. Room for dealing with unexpected is excellent.
- The project team members are well experienced in designing and implementing vehicle demonstration programs.
- Well-structured approach.
- Multiple climates identified, but not clear if vehicles will be left out in sub-zero weather for several days before startup.
- Good/reasonable distribution of vehicles in three climates.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.2** based on accomplishments.

- Good results were found on vehicle and systems performance.
- Customer acceptance study is a very good accomplishment for market development.
- Great start. Not clear what has been learned so far.
- Well planned and conducted beginning.
- Program in startup phase.

- Vehicles and early hydrogen delivery systems being put in place.
- Excellent collection of vehicles already in operation.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.6** for technology transfer and collaboration.

- A competent, strong team that will deliver.
- Good team formed for program.
- Commitment of data to DOE critical.
- Data provided to NREL.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.4** for proposed future work.

- Cost analysis was not adequately addressed
- The next 4 years will be of immense value to the DOE programs.
- Program appears well structured.
- Proposed activities meet the DOE requirements, but future work would benefit from a more detailed technology transfer and technology improvement plan.

Strengths and weaknesses

Strengths
- Customer acceptance study.
- Automated on-board data collection.
- Outstanding plans, vehicles, and facilities.
- An extremely well planned project that brings together the major industry players.
- Great plan for technology validation and customer acceptance.

Weaknesses
- Not clear how results is presented or to whom. Are the detailed failure incidents reports available for the total DOE effort to use?
- None evident.
- Lack of information on how information from this activity will be used to improve the technology and overcome the technical and market barriers.

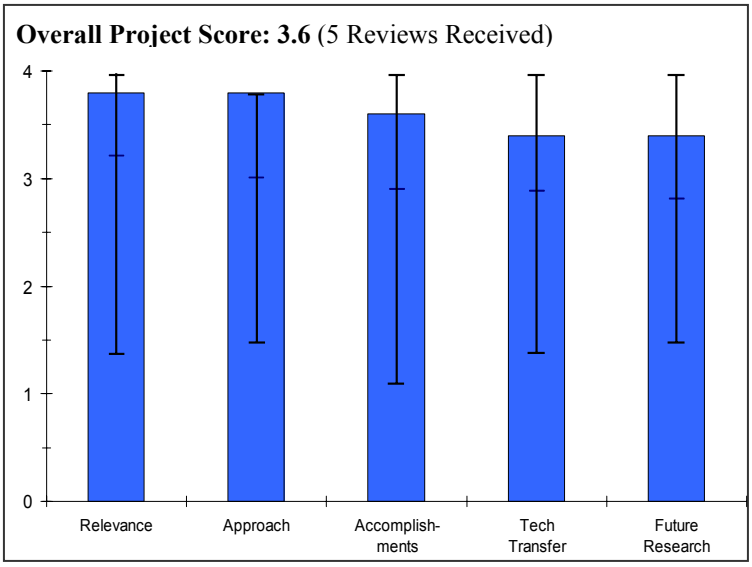
Specific recommendations and additions or deletions to the work scope

- To be more detailed on customer response. Not only are in-depth interviews with partner organizations necessary, but also structured interviews with drivers (level of information on vehicle and fuel technologies, evaluation of drivers feeling about driving experience, statistical analysis of troubleshooting, etc.).
- An important part of technology demonstration is the economic viability. The project must address the efforts to reduce technology costs (vehicle and fuel cell price reduction strategy, total cost per mile, etc.).
- Make as much failure data as possible available to as many people as possible.
- No changes needed at the moment.
- Prepare a more detailed technology transfer plan.

Project # TV-10: Hydrogen Fuel Cell Vehicle & Infrastructure Demonstration Program Review
Frenette, Greg; Ford

Brief Summary of Project

Hydrogen fueled vehicles, utilizing current fuel cell system concepts, will be placed in fleet user service in three varied climatic regions to demonstrate the efficiency, reliability and durability of the fuel cell power concept, and to validate the concepts through the collection of real-world data. In parallel, hydrogen fueling stations will be sited to establish an initial hydrogen infrastructure, demonstrate alternative production concepts, and evaluate production technologies for cost effectiveness. Emerging technologies in vehicle and hydrogen infrastructure will be validated in separate, advanced engineering vehicles and fuel cell system designs that demonstrate improved functionality, range, durability, economy, weight and cost.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.8** for its relevance to DOE objectives.

- Gets at the realities of auto fuel cells very well.
- Of paramount relevance to DOE's fuel cell vehicle programs.
- Program results should provide important database for operation of fuel cell vehicles, delivery of hydrogen, and production of hydrogen.
- Program should provide critical safety / hazards database.
- Database collection and dissemination will provide confidence level for public.
- Addressing most of the critical barriers.

Question 2: Approach to performing the research and development

This project was rated **3.8** on its approach.

- Excellent.
- The stakeholders are very proficient in designing and implementing vehicle demonstration programs.
- Well structured approach.
- Multiple climates identified, but not clear if vehicles will be left out in sub-zero weather for several days before startup.
- Appears a second more advanced vehicle design is being held in-house for R&D.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.6** based on accomplishments.

- None.
- Well planned and conducted beginning to the project. The delivery of vehicles is well underway.
- Program in startup phase.
- Vehicles and early hydrogen delivery systems being put in place.

- Accomplishments appear to be good, but it is difficult to determine what was done prior to and since the beginning of this project.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.4** for technology transfer and collaboration.

- Well-defined partner's roles.
- Need detailed data and failure mode information sharing.
- The collaboration between these project team members will ensure a very successful outcome.
- Good team formed for program.
- Commitment of data to DOE critical.
- Acknowledged the need to transfer data to NREL, but not the value of that activity.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.4** for proposed future work.

- Cost analysis was not adequately addressed.
- The next 4 years will be of immense value to the DOE programs.
- Program appears well structured.
- Place vehicles and fueling stations in three regions.

Strengths and weaknesses

Strengths
- On-board data collection system.
- Aggressive tests can be important to validate technologies.
- Everything is great.
- An extremely well planned project that brings together the major industry players.
- Overall, a great validation project.

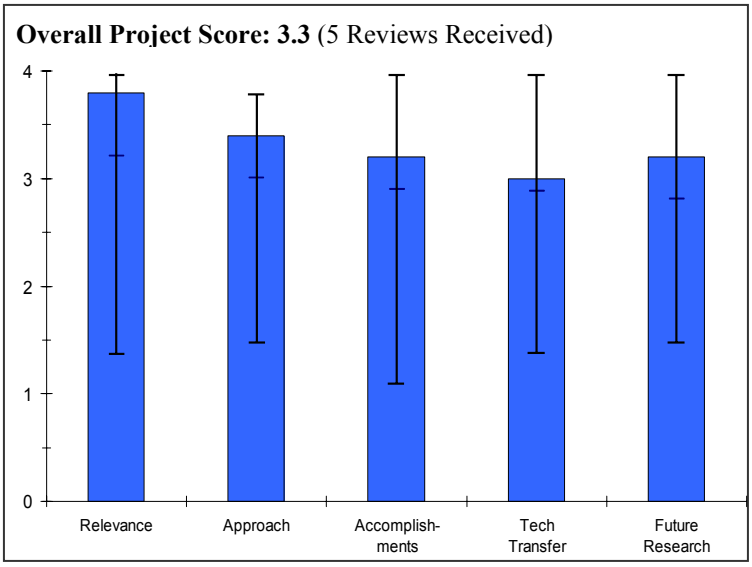
Weaknesses
- Sharing all information with everyone needs to be included in the program.
- None evident.
- Lack of recognition of value of technology transfer and reaching out to other organizations for help when technology shortfalls occur.

Specific recommendations and additions or deletions to the work scope

- An important part of technology demonstration is the economic viability. The project must address the efforts to reduce technology costs (vehicle and fuel cell price reduction strategy, total cost per mile, etc.).
- Detailed project results, failure modes, root cause, etc. data needs to be fully shared with all DOE participants.
- No changes needed at the moment.
- This project could be improved by developing a detailed plan describing how the 18 vehicles in this project will interface with the 12 additional vehicles being built.

Project # TV-11: Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project
Paulose, Rajesh; ChevronTexaco Corp.

Brief Summary of Project



ChevronTexaco Corp., Hyundai Motor Co. and UTC Fuel Cells will lead a five-year demonstration and validation project designed to showcase how fuel cell vehicles (FCVs) and hydrogen infrastructure can be designed to work together to fuel vehicles of the future. The primary goal of this public–private partnership is to demonstrate up to six hydrogen energy stations (primarily in Southern California, with one site elsewhere to test cold climate conditions) and up to 32 FCVs as well as inform key audiences about hydrogen as a potential vehicle fuel. In addition, important safety and legal codes and standards for hydrogen refueling technologies will be developed in conjunction with the federal government and other authorities. Hyundai will provide a fleet of up to 32 vehicles, powered by UTC Fuel Cells' power plants. Hydrogen at the refueling stations will be generated using different types of natural gas reformer technologies and electrolysis. Some of the hydrogen stations will also include a stationary fuel cell to co-generate power. Other collaborators include Southern California Edison, Hyundai KIA America Technical Center, Inc. and Alameda Contra Costa Transit, who will serve as vehicle fleet operators and site hosts for hydrogen fueling and power generation stations.

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.8** for its relevance to DOE objectives.

- To understand how an average individual would react to fuel cell cars and hydrogen fueling stations is a very important objective of this project.
- Of paramount relevance to DOE's fuel cell vehicle programs.
- Program results should provide important database for operation of fuel cell vehicles, delivery of hydrogen, and production of hydrogen.
- Program should provide critical safety / hazards database.
- Database collection and dissemination will provide confidence level for public.
- Validation of the technologies is very relevant.

Question 2: Approach to performing the research and development

This project was rated **3.4** on its approach.

- Not enough emphasis on data evaluation. What are they collecting? Is it just a fuel and car system?
- The project members are very competent in planning and carrying out vehicle demo programs.
- Well structured approach.
- Multiple climates identified, but not clear if vehicles will be left out in sub-zero weather for several days before startup.
- Good approach, but could be improved with more detailed planning on what will be required in the infrastructure area.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.2** based on accomplishments.

- Too early to tell.
- Well-planned and well-conducted beginning to the project.
- Program in startup phase.
- Vehicles and early hydrogen delivery systems being put in place.
- This team seems to be starting slowly.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.0** for technology transfer and collaboration.

- PI has not clearly identified the roles of partners and the information management.
- Need to share failure data with competitors, as least as much as possible.
- This strong team will make sure the project is successful.
- Good team formed for program.
- Commitment of data to DOE critical
- This team does not appear to understand the importance of technology transfer.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.2** for proposed future work.

- Cost analysis was not adequately addressed.
- Not clear - beyond the obvious.
- The next 4 years will be of immense value to the DOE programs.
- Program appears well structured.
- Future plans are going in the right direction, but they seem to be uncertain about many aspects, such as the number of stations they plan to open.

Strengths and weaknesses

Strengths
- O.K.
- The major industry players are keen to see this project succeed.
- Planned/anticipate improvements to fuel cell vehicles.

Weaknesses
- Could be more detailed about what is expected to be learned and how the results will be used and shared.
- None evident.
- Project seems to be off to a slow start.

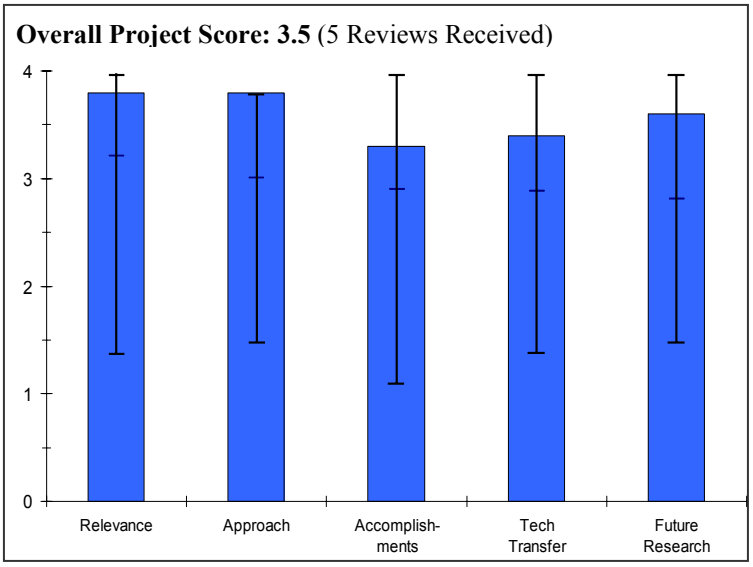
Specific recommendations and additions or deletions to the work scope

- An important part of technology demonstration is the economic viability. The project must address the efforts to reduce technology costs (vehicle and fuel cell price reduction strategy, total cost per mile, etc.).
- More specifics about what data is to be acquired and how it will be used.
- No change presently needed.
- Strengthen plan in the areas of infrastructure development and technology transfer.

Project # TV-12: Hydrogen Vehicle and Infrastructure Demonstration and Validation
Sell, Roz; General Motors

Brief Summary of Project

General Motors will conduct a demonstration project to validate forty Opel Zafira Generation 1 fuel cell vehicles fueled with hydrogen from stations in three locations chosen from the following: Washington, D.C.; Ft. Belvoir, Virginia; Southern and Northern California; Detroit, Michigan; and New York City, New York. The project will identify technology issues and address them in a second-generation vehicle.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.8** for its relevance to DOE objectives.

- Of paramount importance to DOE's fuel cell vehicle programs. Although the claim of several 'world's first' are not really relevant to the DOE's R&D plans.
- Program results should provide important database for operation of fuel cell vehicles, delivery of hydrogen, and production of hydrogen.
- Program should provide critical safety / hazards database.
- Database collection and dissemination will provide confidence level for public.

Question 2: Approach to performing the research and development

This project was rated **3.8** on its approach.

- Good emphasis on standard development.
- Great.
- The team assembled is very experienced in formulating and executing vehicle demo programs.
- Well-structured approach.
- Multiple climates identified, but not clear if vehicles will be left out in sub-zero weather for several days before startup.
- Plan for implementing two generations of fuel cells is great.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.3** based on accomplishments.

- New project.
- The project has gotten off to a great start.
- Program in startup phase.
- Vehicles and early hydrogen delivery systems being put in place.
- Great progress, probably indicative of work initiation prior to contract award.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.4** for technology transfer and collaboration.

- Good arrangement, with roles distributed to the different partners.
- Plan for problem reporting and sharing not clear.
- Need detailed FMEA analysis to be shared with competitors.
- A successful outcome to this project can be assured.
- Good team formed for program.
- Commitment of data to DOE critical.
- Acknowledge the need to transfer data to NREL, but not the value of that activity.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.6** for proposed future work.

- PI could give more details on near and long term future.
- Cost analysis was not adequately addressed.
- None.
- The next 4 years will be immense value to the DOE programs.
- Program appears well structured.

Strengths and weaknesses

Strengths
- Looks like a great plan and clearly is covered well by a great team.
- A very capable team has come together in this project.
- Overall, a great validation project with planned vehicle improvements.

Weaknesses
- Failure and mitigation reporting not defined or shared.
- None evident (or even allowed)!
- Lack of recognition of value of technology transfer and reaching out to other organizations for help when technology shortfalls occur.

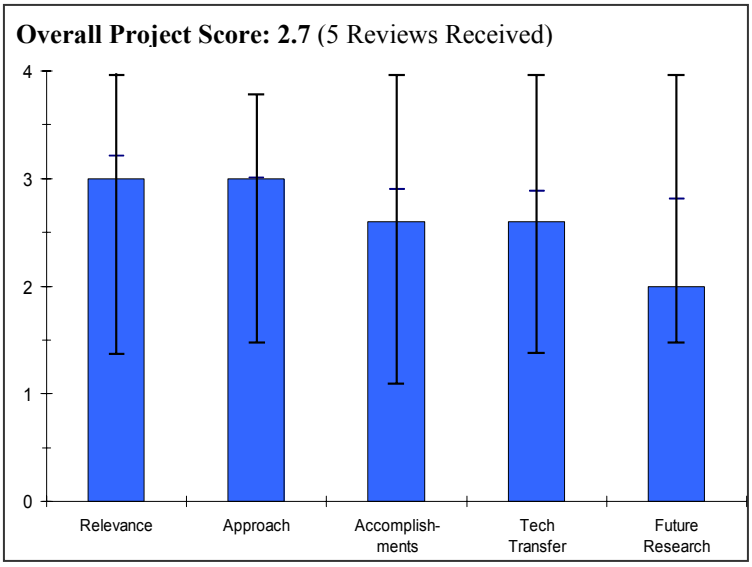
Specific recommendations and additions or deletions to the work scope

- An important part of technology demonstration is the economic viability. The project must address the efforts to reduce technology costs (vehicle and fuel cell price reduction strategy, total cost per mile, etc.).
- Report all incidents in detail for all DOE program participants to share.
- If it ain't broke, don't fix it!
- A more detailed technology transfer plan would be helpful.

Project # TVP-01: Hydrogen from Biomass for Urban Transportation
Bota, Kofi; Clark Atlanta University

Brief Summary of Project

Clark Atlanta University and its collaborators, focused on producing hydrogen from biomass, produced 25 kg/day of hydrogen from peanut shells for urban transportation. This process involved pyrolysis of the biomass followed by catalytic steam reforming of the gas and bio-oil products to produce hydrogen. Successful operation of 100 hours demonstrated the technical feasibility of the process, identified agricultural uses of the carbon product, and identified economical co-product options for the bio-oil. Current efforts are focused on completing a 1,000 hour demonstration of the process.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.0** for its relevance to DOE objectives.

- Design of the project did not include analyzing the process steps to reduce costs or energy inputs.
- Low cost. Realization of need for productivity. There are a lot of biomass pathways and this is a good example.
- Good bench/ prototype test demo of organic fueled generation of H_2 but nothing really unique.
- Hydrogen from biomass technology validation is consistent with HFCIT program objectives.
- The role of biomass in future hydrogen systems is very important, and a goal of DOE, because it is a renewable resource and it also eliminates waste products which themselves produce green gas gases when they decay.
- The project cost goal of $2.30/kg appears to be consistent with DOE's new goal of $2 to $3/gge.

Question 2: Approach to performing the research and development

This project was rated **3.0** on its approach.

- "Proof of principle" approach showed that peanut shells can provide a source of hydrogen.
- Principle demonstrated, but nothing done in this project to overcome barriers, define process constraints, and identify logical next steps.
- Process only operated continuously for a few hours.
- Seeking multiple co-products from biomass to hydrogen process. Two years of project - 200 hrs of runtime. The system design seems innovative.
- Need to analyze economic data to determine dependence on waste utilization.
- Prudent technical approach considering funding level.
- No hydrogen purification included due to limited funds/scope.
- The project was creative in developing a byproduct with agricultural value to help reduce the effective cost of the hydrogen.
- The ability to handle wet agricultural residues is a real plus.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.6** based on accomplishments.

- No process cost data or projections.
- No measuring of energy inputs - propane, electricity - required to produce hydrogen energy.
- Longest continuous period of operation was a few hours.
- Feedstock (peanut shells) input was intermittent.
- Is innovative. Fertilizer products from peanut shells would be useful.
- Good demonstration of process feasibility.
- Good accomplishments relative to funding.
- Produced useful data regarding hydrogen yield from one type of biomass.
- The project is a technical success.
- It is not clear from the presentation whether the project met its cost goals, or how the resulting costs relate to DOE cost goals.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **2.6** for technology transfer and collaboration.

- Two thirds of funds went to Eprida, a sub-contractor.
- Roles of the university unclear.
- Should expand publicity.
- No evidence that results are being transferred to other HFCIT projects.
- It is hard for a university to do technology transfer to industry but this project had a number of important partners including NREL, ORNL and Georgia Tech, which should help ensure that the results are shared more widely.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.0** for proposed future work.

- PI would like to do more work, but nothing specific proposed.
- Hydrogen purification. Systemic characterization. Georgia Tech scale up future.
- Other than more and longer testing, no specific goals were mentioned.
- Project complete.
- Future plans not presented.
- No future research is recommended or planned for this completed project, although the presenter did indicate that the next step would be to scale it up.

Strengths and weaknesses

Strengths

- Skid mounted approach to mechanize prototype is smart.
- Good tech abilities. Good collaboration between academia and industry.
- Early demonstration of hydrogen from biomass.
- Generated useful quantitative data.
- Important message regarding benefits of producing biomass byproducts in addition to hydrogen.
- The project demonstrated good collaborative college, national laboratory and small industry work.
- The project was a technical success.
- The project was integrated into student work

Weaknesses

- Minimal useful data, results achieved for relatively large DOE resources expended.
- Durable catalyst still needed. It seems like a lot of partners are claimed but their role and contributions unclear.
- Carbon balances are issues.
- Lack of purification (due to limited scope/funds) made results seem less directly relevant to HFCIT goals.
- Technology transfer (utilization by others) not obvious.
- The person that did most of the talking was Danny Day who seemed to be representing Enviro-Tech Enterprises. Zach Wang and Kofi Bota were knowledgeable and helpful when given a chance to talk.

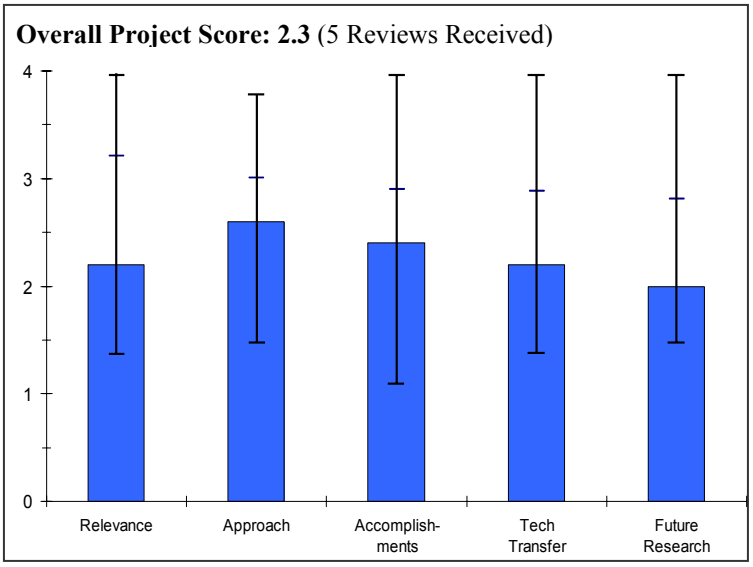
Specific recommendations and additions or deletions to the work scope

- No follow-on work is recommended for this project.
- It is important that this team focuses on their potential value added and doesn't try to re-invent catalysts, purification or devices that they can buy to incrementally improve the system.
- HFCIT Systems Analysis and Systems Integration activities should utilize results from this project.
- Possible follow-on work recommendations were not presented.
- Consider an assessment by ORNL and NREL to determine if there is merit to further work, including scale-up.

Project # TVP-02: Chattanooga Fuel Cell Demonstration Project
Ferguson, Joe; City of Chattanooga

Brief Summary of Project

Through The Enterprise Center and its Connect the Valley Initiative, the City of Chattanooga plans to facilitate cooperative efforts between Ion America of Moffett Field, California, the City of Chattanooga, and the University of Tennessee at Chattanooga (UTC) to develop and demonstrate a prototype 5 kW class, grid parallel, solid oxide fuel cell system that co-produces hydrogen. This project provides technology validation of a near-term economical pathway to help build out the hydrogen infrastructure. The system to be validated operates with high capacity factor even when the demand for hydrogen is relatively low.



Question 1: Relevance to overall DOE objectives

This project earned a score of **2.2** for its relevance to DOE objectives.

- Shows outstanding promise in terms of relevance.
- The question is will this flexibility to produce hydrogen or electricity become successful or not.
- This is an interesting project but it is not clear that it adequately addresses the hydrogen program cost goals.
- The co-production of hydrogen and electricity is a very important aspect for future hydrogen systems and it may be cost-effective.
- The program does not emphasize direct hydrogen production but only considers hydrogen production as a by-product.
- Program emphasis appears to be SOFC installation.
- The concept seems like an excellent transition technology to still operate at a high efficiency (through producing electricity) even while the number of vehicles that would likely be refueled would be small.
- There is no evidence of research to advance the technology, but rather a very expensive and risky build and test activity.

Question 2: Approach to performing the research and development

This project was rated **2.6** on its approach.

- Solid approach.
- Proving the approach with unproven solid oxide technology combines the risk of the approach with the risk of unnecessary fuel cell technology.
- The project is trying to do too many things.
- The project does not seem well designed.
- Approach may be flawed due to endothermic reforming of natural gas.
- To produce extra hydrogen for vehicle applications high amounts of natural gas must be introduced into SOFC and the endothermic reaction will cool the cell.
- No engineering analysis to determine if SOFC should be designed for power, heat production or hydrogen production.
- Cost analysis not in approach.
- Project seems well thought-out and designed.

- Performing demonstration/validation on a larger sized system (say 100 kW, rather than 5 kW) would provide more value to the program by removing questions of scale-up.
- This approach is very high risk and is not likely to achieve a 5 kW system as planned.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.4** based on accomplishments.

- Does not deal with CO_2 production issue.
- Maybe it is too early, but there is much being attempted here, with little clarity of focus.
- Good progress toward constructing installation.
- No activity to determine what the proper operating point should be and the cost of the integrated equipment.
- While project is well funded for FY05, progress to date seems slow. Seems questionable whether system can be built, tested, and validated within remaining 4 months of project.
- Chart #2 indicates the project is 50% complete; however, to date only 1kW has been demonstrated and the electrolyzer and electrolytes have not been selected for the 5 kW stacks.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **2.2** for technology transfer and collaboration.

- Some interface to auto industry should be included. (Presenter mentioned a desire to provide home hydrogen auto fueling).
- It is quite possible that the lack of industry and other outside collaboration that is this project's weakest aspect.
- The evidence for technology transfer is weak.
- Industry / university collaboration.
- Papers to be published.
- Interactions and collaborations with others seem limited.
- Not clear how many component suppliers are involved in project from a development perspective vs. simply selling off-the-shelf components.
- Project relevance to the Hydrogen Initiative and probability of success would be greatly enhanced if a national laboratory or other research institution with SOFC experience were added to the team to perform research addressing critical barriers.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.0** for proposed future work.

- Should minimize CO_2 release into atmosphere.
- While the future work items are listed, there is little evidence of anticipating problems, or the experience of a proven research approach.
- Engineering analysis of thermal balance and cost analysis are needed to confirm viability.
- Does not seem likely that the large amount of work proposed (and needed) can be completed in next 4 months unless rate of progress on project is accelerated.
- All activities are built and tested with no evidence of research planned.

Strengths and weaknesses

Strengths

- Very specifically focused.
- Co-production of hydrogen and electricity is a concept that deserves research attention.
- Novel and promising approach to deal with both limited need for hydrogen production at the beginning, while still being able to run at high capacity by producing electricity when more hydrogen is not needed.
- Ion America claims to have demonstrated planer SOFC with no leaks.

Weaknesses

- Doesn't consider side effects sufficiently.
- Too much development of new equipment is attempted without fixing some of the variables with proven technology.
- Experienced industry collaboration, including the solid oxide fuel cell developer, is non-existent.
- While linear plot showing potential mixes between hydrogen production rate and electricity production was shown, trade-offs in terms of overall system efficiency not explored.
- This project is structured as if all barriers have been addressed and full commercialization is only a year away.
- Private sector cost share for this validation/demonstration project is inappropriate and excessively low.

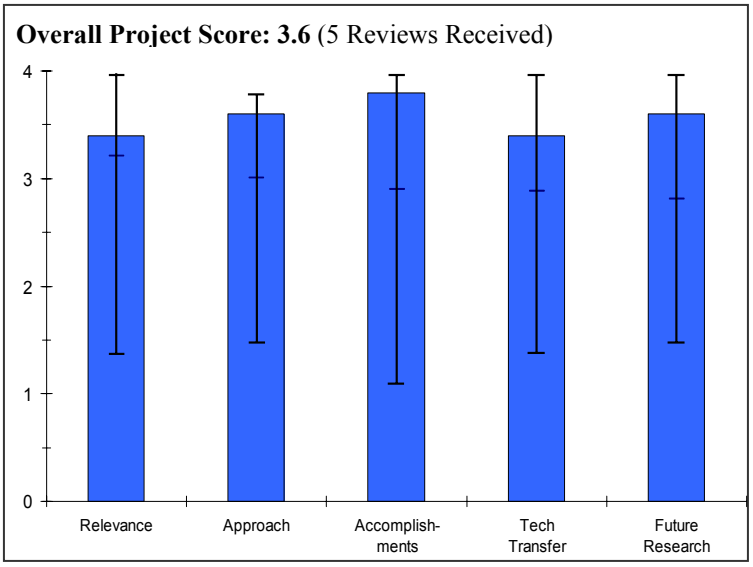
Specific recommendations and additions or deletions to the work scope

- CO_2 release concern.
- Automotive interface needed.
- Discontinuing this project should be considered unless the research scope can be adequately focused on achievable objectives that fit with the hydrogen program needs.
- Prior to further construction, the viability of the concept should be established with an engineering analysis. Possibly an outside team should conduct that analysis.
- Try to find private investor support to scale this system up to 100 kW size for more realistic validation.
- Explore tradeoffs in efficiency between H_2 and electricity production more fully.
- Restructure the project to address the barriers of cost and performance of SOFCs.

Project # TVP-04: Power Parks System Simulation
Lutz, Andy; Sandia National Laboratories

Brief Summary of Project

Power parks combine power generation co-located with a business, an industrial energy user, or a domestic village. In this project, Sandia National Laboratories (SNL) is developing a flexible power park system model to simulate distributed power generation in energy systems that use hydrogen as an energy carrier. The project analyzes the performance of demonstration systems for the Technology Validation program. Deliverables include a flexible computational tool to provide simulations of a variety of energy systems that produce hydrogen and independent analysis of system performance, thermodynamic efficiency and cost of hydrogen/electricity.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.4** for its relevance to DOE objectives.

- System model.
- Looks like a good tool for analysis of power park elements as well as comparing parks.
- Appropriate to apply data from other technology validation projects to analyze and model technologies.
- Overlaps or complements HFCIT Systems Integration and Systems Analysis activities.
- This is a great project, at a relatively low cost that will address the unknowns that everyone is interested in... the potential for lower cost hydrogen production in a more complicated environment of co-production of electricity.
- This project will undoubtedly provide excellent simulation tools to DOE's technology validation activities.

Question 2: Approach to performing the research and development

This project was rated **3.6** on its approach.

- Within the constraint of using the designated software, this seems valid.
- PI is obviously very skilled in this area. Sound modeling approach.
- Consider approaches to enable broader dissemination of analytical models (e.g., to researchers without Simulink software).
- The approach relies on industry partners, real data and solid modeling experience.
- There are problems in a project like this but this project is robust in its use of existing experience and information.
- The PI has a comprehensive understanding of is mission and deliverables.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.8** based on accomplishments.

- Library of models is simulink. Should be expanded but has a good start.
- Working well with real inputs.
- Excellent work quality and productivity relative to funds consumed.
- Solid progress, in each of the power park examples, is evident.
- Improved performance of power parks, or possibly recognition that this is not the most economical approach to hydrogen production, will result. In either case, this work will pay for itself in reduced public dollars.
- The development of simulation models and their preliminary trials have progressed very well.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.4** for technology transfer and collaboration.

- Collaborating with the 3 major power park projects i.e., DTE, APS, and Hawaii.
- PI is making obvious effort to disseminate results.
- This project has a most impressive list of collaborators, virtually anyone currently involved in building and demonstrating power parks.
- Good so far, but it is imperative that all of the simulation models within the DOE HFCIT program interface well with each other i.e., incompatibilities.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.6** for proposed future work.

- Graphics user-interface to allow non-specialist to use model.
- GUI work excellent for broad public use.
- Project is carefully planned.
- The plans to make the results user-friendly and to validate the model with existing power parks will bring this effort a lot of credibility.
- The PI clearly knows what's needed to be done and will pursue it enthusiastically.

Strengths and weaknesses

Strengths
- Willingness to share with simulink users.
- Good central understanding of all elements.
- High quality technical work.
- Beneficial analysis of power park project data.
- Open availability of results.
- A sound research approach, all the important industry partners, and plans to make the results useful to others are important strengths of this project
- PI enthusiasm and realism is a big asset.

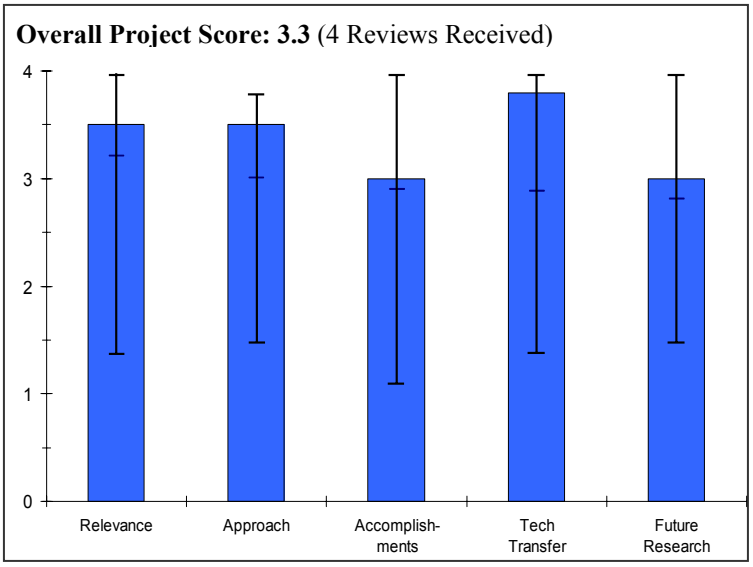
Weaknesses
- Seems to disregard the money modeling efforts which have come before. The rationale of starting over in modeling with a "black box functional building blocks" unclear.
- What is plan for interfacing results with HFCIT Systems Analysis and Systems Integration activities?
- Utilization of output models requires Simulink software.
- It is possible that this project is taking on too much with too little funding.
- Could benefit from more 'real world' system and sub system operational data from industry participants.

Specific recommendations and additions or deletions to the work scope

- Agree with creation of graphics interface (GUI) in the continuation of this project with the assurance that more stakeholders have eventual access to this tool for free.
- Keep analyzing more data.
- Continue high-quality work.
- Be more proactive with technology validation power park projects to ensure good quality data.
- Increase communication of "what the data is telling us" results as well as the models.
- Be sure that the project team reports to all organizations considering power parks, either as public decision makers, or as businesses or power park developers.
- No changes needed.

Project # TVP-05: Technology Validation: Fuel Cell Bus Evaluations
Eudy, Leslie; National Renewable Energy Laboratory

Brief Summary of Project



This National Renewable Energy Laboratory (NREL) project involves collecting operational and performance data on fuel cell buses in real-world service. The results will help assess the status of fuel cell systems for buses, determine issues that need further development, and provide the "lessons learned" to aid other fleets in implementing the next generation fuel cell systems into their operations. In coordination with industry partners, NREL is working to harmonize these data collection efforts with other fuel cell bus demonstration projects around the world. The team is also working to collect more detailed data on the vehicles and infrastructure similar to that of the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project.

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- Evaluates buses in service.
- Real world experience is a high priority.
- Evaluating the performance and maintenance of the hydrogen buses in operation today is critically important.
- This project is a very effective way to increase the learning from buses worldwide.
- Validation plans well conceived and implemented.

Question 2: Approach to performing the research and development

This project was rated **3.5** on its approach.

- Ballard Fuel Cell, Hydrogenics, UTC, ISE. Fuel cell buses treated like black boxes.
- Would be improved to be able to compare results between the 4 different approaches represented. Perhaps some "common route" testing.
- There is much to like about this project.
- It is cost-effectively evaluating existing buses, not deploying new buses with larger amounts of funding necessary.
- It is utilizing common data analysis approaches across a diverse set of bus operations and companies, including international programs like the CUTE program.
- The project is using their data, not forcing the creation of new data gathering efforts.
- The PI has a good appreciation of the issues and objectives.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.0** based on accomplishments.

- Fleet customers.
- The project seems on schedule, as buses are deployed and developing important operational and maintenance data.
- It is not clear whether cost data being developed as well.
- Early days yet for data analysis.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.8** for technology transfer and collaboration.

- This project is collaborating with all fuel cell bus manufacturers, all bus fuel cell manufacturers and all the programs, UC-Davis, as well as U.S. FTA and other organizations.
- This project goes beyond U.S. bus demos to European and other national programs.
- Excellent teamwork and coordination is paying off.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.0** for proposed future work.

- Desires to move into other fleets. The project should show it can work with these fleets before expanding.
- The project will finish up with bus projects just beginning.
- The results of the data analysis will be crucial in revealing the value of this effort.

Strengths and weaknesses

Strengths
- I appreciate her ability to get these fleets to cooperate with her.
- Clear mission and strong management focus.
- The project is appropriately using data that others are gathering, their own data, instead of gathering its own data. This gives the project credibility.
- The project is using all bus projects that are available.
- The operational experience of the fleet operators, bus manufacturers, and natural enthusiasm of the PI will bring success.

Weaknesses
- It is uncertain how much unedited reality will emerge from this work vs. a packaging of the hardware supplier's version of their own performance.
- Needs more ability to compare results for different alternative bus and fuel cell configurations.
- It is not clear that economic data is being gathered, although that may be difficult and not necessary at this early stage. It is more important to know how much hydrogen is used than what was paid for it, for example.
- None evident at this stage.

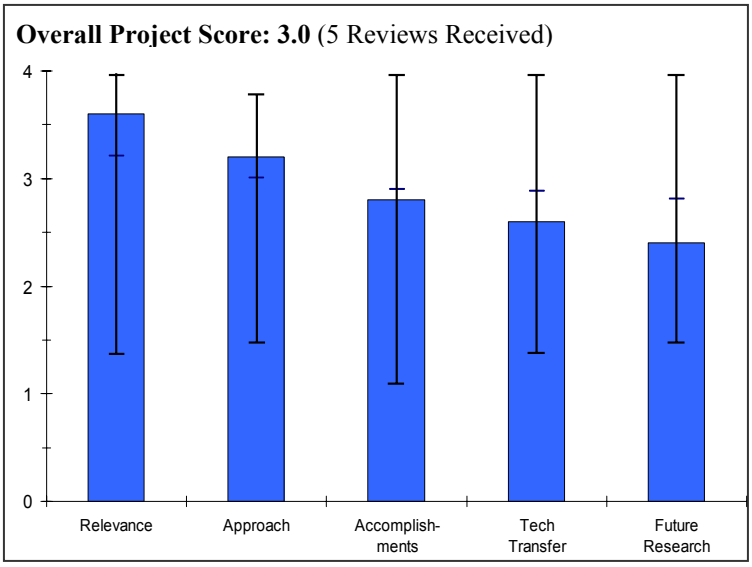
Specific recommendations and additions or deletions to the work scope

- A firm commitment to data integrity seems absent and an admission that access to these fleets could be jeopardized by supplier subjective reactions to her reporting was of concern.
- Add some degree of comparison of results for common routes.
- Document cost information that might be important as a baseline, like bus costs, fueling station costs, etc.
- Review justification for any further effort at the 4th 2006 workshop.

Project # TVP-06: Auto-Thermal Reforming Based Refueling Station at SunLine
Harness, John; HyRadix/SunLine

Brief Summary of Project

Hyradix and SunLine are working together to develop an on-site natural gas autothermal reforming system for vehicle refueling. This reformer will advance sulfur removal technology, purify the fuel stream through pressure swing adsorption, and be integrated with compression and storage systems designed by SunLine. The high-purity hydrogen will be compressed and stored at 3,500 psi for blending with CNG and at 6,000 psi for use in hydrogen ICE and fuel cell vehicles. The hydrogen and hydrogen enriched natural gas (HCNG) will refuel fuel cell and HCNG buses, street sweepers, and cars.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.6** for its relevance to DOE objectives.

- A functional reformer is necessary.
- Good demo of actual use of ATR.
- This project supports the development of a fueling station-sized, lower-cost hydrogen production technique that utilizes lower temperatures, less fuel and lower cost materials.
- Hydrogen cost is one of the critical barriers to a hydrogen future. If it can produced at low cost nearer the point of use, distributed production, the transportation costs can be avoided, reducing the cost of the delivered fuel.
- This project has high-relevance to DOE's program because it provides a transition strategy before hydrogen infrastructure is widespread.
- Early experience from this project provided great value to SunLine, who is a leader in hydrogen transportation implementation for buses.
- Project provides an interim solution to hydrogen production and delivery, which can be used in the early phases of the transition to a hydrogen economy.

Question 2: Approach to performing the research and development

This project was rated **3.2** on its approach.

- In-house sulfur removal is cost effective for the flow delivered ($3.68 kg). The gas quality and cost performance are represented as useful to hydrogen energy.
- Good but utilization needs to be increased to verify durability and costs.
- The approach is sound to achieve the goals, and the technique has relatively fast start-up, 3 hours from cold start, faster than SMR technology.
- Approach was well laid out to accomplish objectives of the project.
- Approach resulted in reasonable accomplishments.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.8** based on accomplishments.

- It seems this field trial was useful to the contractor but no meaningful data was shown to this reviewer.
- It is not clear that the DOE cost goal for hydrogen can be achieved, although the lack of hydrogen transportation costs may be sufficient to support a higher cost.
- This appears to have been a very successful project.
- CO impurities were stated in % (0.03%), which is 3/10000, or 300 parts per million. There must be a PSA to clean this up for use in a fuel cell, but that is not discussed.
- Cost of $3.68/kg appears to be good progress toward $3.00 goal.
- Excellent that this resulted in a commercial product with at least one order for the product.
- Good documentation of problems encountered.
- Project identified engineering improvements that can be made to further improve the system and make it more viable as an interim production/delivery solution.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **2.6** for technology transfer and collaboration.

- SunLine is a demo site but has little value added and seems unwilling to comment on the project.
- This is a great showplace with lots of exposure.
- Collaboration with SCAQMD is a plus.
- It is not clear how the results will be useable by other companies, although it is clear that the contractor is moving ahead with commercialization of the technology and that the public will benefit from an alternative approach to hydrogen production at the fueling station.
- Good collaborations led to a successful project.
- There is no evidence that technology transfer to others performing research in this area is taking place.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.4** for proposed future work.

- Close out. The contractor representing this hardware is commercial therefore this should be cleared out.
- Could do more run time and utilization but until demand rises what else needs to be demonstrated? It works.
- The contractor's plans are clear and there is great hope for the results of this project.
- Future work looks reasonable.
- If market introduction is not profitable, what is the plan to reduce costs, improve performance, etc. to move to profitability?
- Future plans will make incremental improvements to this system, but will not achieve long term initiative goals.

Strengths and weaknesses

Strengths

- Good equipment and capabilities. Good showcase facility.
- The contractor had a clear pathway to a potential commercial product and proved that it was feasible, an approach that will have public benefit.
- The project resulted in hydrogen production cost information.
- Project successfully completed and turned into commercial project. It doesn't get much better than that as far as a success story.
- Provides a hydrogen production and delivery system that is available today.

Weaknesses

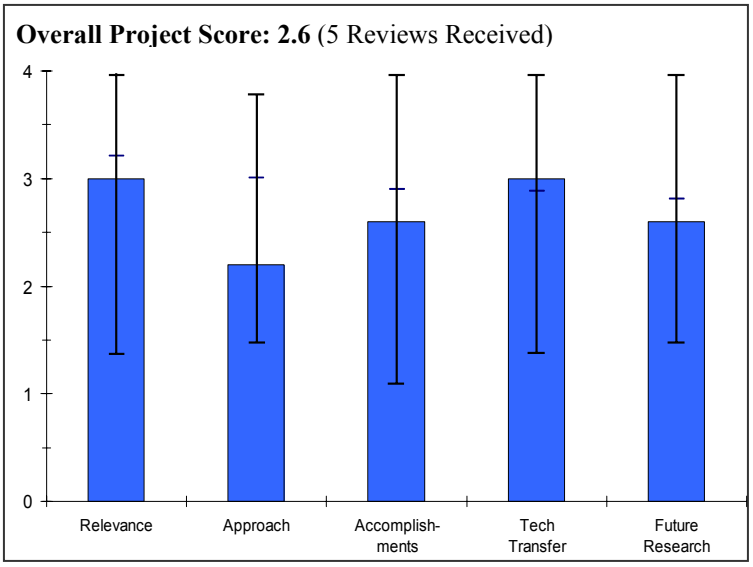
- A clear report, verified by a credible party, that the hardware functions as represented.
- Need more uses for the fuels.
- The DOE cost goal is not clearly met yet, but with the avoidance of transportation costs, this approach may provide a net economic benefit.
- While it may be proprietary, an idea of how Hyradix will approach the market: what niches, where does it make most sense from a consumer perspective, etc.?
- Reformation of natural gas is not a long-term solution to our energy problem.

Specific recommendations and additions or deletions to the work scope

- Contractor says the hardware can be bought and that it doesn't need government help.
- It would be interesting to develop experience data with the next generation of autothermal reformers from Hyradix.
- Project is completed.
- Identify market niches and go after them aggressively. The hydrogen investment community could use some examples of profitable companies to learn from.
- Project is completed and technology is being commercialized.

Project # TVP-08: Hydrogen Filling Station
Boehm, Robert; University of Nevada, Las Vegas

Brief Summary of Project



As a first step in the development of a hydrogen utilization network, the University of Nevada-Las Vegas Research Foundation is installing and analyzing the performance of a hydrogen fueling system powered by solar energy. Objectives included development of the requirements for the fueling system, survey of potential sites and determining favorable/unfavorable characteristics of each, selection of the site with site plan and support to the site permitting process, design of the fueling system layout, installation of the fueling station in Las Vegas, monitoring operation of the fueling system, and characterizing performance. In the second step of the process, the refilling station is being supplemented with a high-pressure electrolyzer that is being developed for this project. In addition, two utility vehicles are being converted to use hydrogen as fuel. One of these is an electric vehicle that will function as a hybrid full cell vehicle. The second involves the conversion of a gasoline-fueled ICE system to a hydrogen-fueled ICE system. For the latter, we are attempting to use direct cylinder injection of the hydrogen. Finally, engineering of tandem solar cell systems is taking place as well as some basic science studies. Hydrogen is produced directly in these cells, and they promise high conversion efficiency. To accomplish this work, the first step is a CFD analysis of the flow and heat transfer within the cell. On-sun experiments are anticipated with a prototype unit during this next year. In the science studies, work on the separation membrane and coatings involved are being carried out.

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.0** for its relevance to DOE objectives.

- Integrated with vehicle fleet operator. Scope includes vehicle conversions, a pickup truck for the water district, and a hydrogen fuel cell hybrid and ICE both renewably driven with a 15 kWPV 15 kW.
- Good solar demo.
- Project objectives are pertinent to HFCIT program goals.
- A field demonstration of high-pressure PEM electrolysis would be useful.
- This project has two important characteristics: renewable production of hydrogen to improve environmental characteristics; and high pressure electrolyzers to reduce costs.
- Other project elements, like conversions of vehicles do less to support the program. This is not important research when done in this context.
- Many of the projects covered by this project are relevant for DOE's program.

Question 2: Approach to performing the research and development

This project was rated **2.2** on its approach.

- Use two PEMs electrolyzer and two compressors. Use an APCI dispenser solar electrolyzer.
- Seems to include too much, i.e., includes vehicle work.
- Work plan does not appear to have been laid out with adequate care.
- Potential for missing technical, schedule, and/or budget objectives appears too significant.
- There are too many research experiments going on this project at the same time.

- Improved solar technology is good, but not necessary in a hydrogen program.
- Conversion of vehicles to use hydrogen is necessary but could be done by experienced retrofitters, without fuel cells.
- Use of solar to produce the hydrogen is an important aspect of this project but it is not necessary to use experimental solar technology.
- Development of a high-pressure electrolyzer is very important for fueling station economics.
- Approach seems very scattered.
- Project looks like a collection of small research projects without a cohesive tie together.
- For this large amount of funding, the project should be better organized and focused.
- Better to apply efforts in a few limited areas and have success, than spread too thin over large number of small projects that have limited chance of technical breakthroughs needed.
- No connection between PEC project and H_2 filling station project.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.6** based on accomplishments.

- In phase 2, a new PEM cell was used to support the membrane to provide output pressure of 2000 psi, a 99.999% hydrogen, and desiccant.
- Still early but seems on track.
- None of the major project elements appear to have been installed at the site yet.
- Presentation did not show originally proposed project schedule.
- The project appears to be behind schedule with results also behind.
- It not clear what benchmarks are being used to judge project success by the researchers.
- Some progress appears to be made on a few of the projects.
- Results not yet conclusive or quantitative.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.0** for technology transfer and collaboration.

- Supply agreement with APCI. Like the use of local engine expert with fresh ideas.
- Working with a reasonable cross section.
- Collaboration appears to be limited to direct project participants so far.
- Proton Energy is a strong partner in the most important work to develop a high pressure electrolyzer.
- Other partners and collaboration do not measure up to the standards expected of this DOE Technology Validation Program.
- Good involvement of students on multiple projects.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.6** for proposed future work.

- I think this project delivers a lot for a small amount of money.
- Scale back to focus on solar and let vehicle people do vehicles.
- FY 05 and FY 06 plans appear to be quite ambitious.
- The planned efforts appear to be designed to finish the project but do not appear to address possible problems or present contingencies, nor expand the knowledge base except by working through the tasks.
- Plans are very high level and a path to completion is not obvious.

Strengths and weaknesses

Strengths
- Will the 2K psi electrolyzer improve system efficiency? Uniquely innovative is the broad array of hydrogen supply options which are corporate in-context. Developing a local expertise.
- Good renewable resources (solar).
- High-pressure electrolysis field demonstration data would be useful.
- Project provides good student learning and hands-on experience.
- Solar energy to produce hydrogen at a fueling station is an important concept to evaluate.
- High pressure electrolysis is considered to be an important possibility to reduce compression costs and therefore reduce the cost of delivered hydrogen to a vehicle with a high pressure tank.
- Topics chosen are relevant for DOE program.

Weaknesses
- Slow because of codes and standards. Local contractors. Direct cylinder fuel injectors.
- Seems spread thin by being too inclusive.
- Project appears to be unlikely to meet all technical, schedule and budget objectives.
- Hydrogen program funding should not be used to develop solar equipment. Commercially viable PV, plus extrapolation to emerging solar technologies would allow the researchers to concentrate on the important aspects of this project.
- Converting hydrogen vehicles in this project is not a good use of hydrogen program funds.
- This project should concentrate on a solar fueling station with high pressure electrolyzers.
- Too many projects selected without a clear thread between them.
- For this amount of funding, a clearer focus and more significant results should be expected.

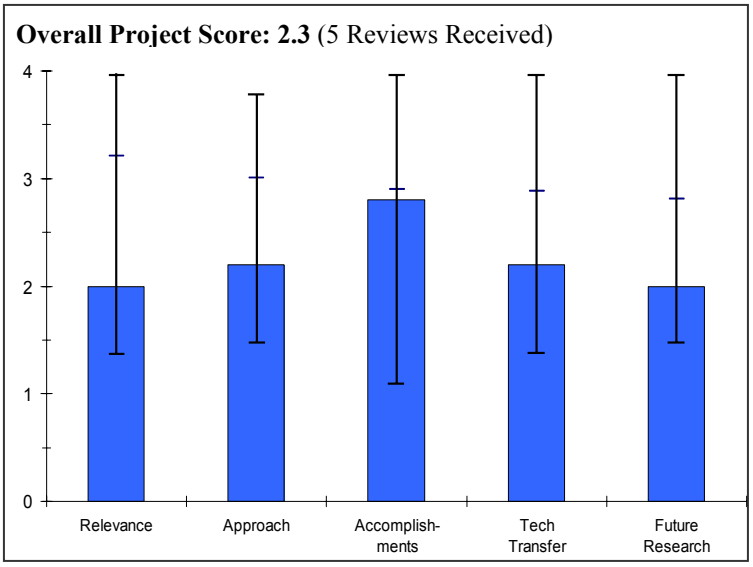
Specific recommendations and additions or deletions to the work scope

- Installation focus for the balance of 2005 field test for solar cell (tandem) - hydrogen solar scale up important.
- Delete vehicle adaptation work and concentrate on a solar fueling station.
- Narrow down the project scope, if needed, for a graceful project completion.
- Re-focus the research on the solar deployment and analysis and new reformer, and the analysis that should be done after the stations is built and utilized.
- Reduce number of projects.
- Focus on results.
- Continue to educate students through projects so that the H_2 community has a strong workforce.

Project # TVP-11: Hydrogen and Natural Gas Blends: Converting Light and Heavy Duty Vehicles
Mulligan, Neal; Collier Technologies Inc.

Brief Summary of Project

Collier Technologies Inc. is developing low-emissions, light- and heavy-duty vehicle engine and retrofit packages to seamlessly repower today's buses and trucks with existing natural gas and diesel engines that will exceed DOE's goal of reducing emissions and maintain or enhance vehicle drivability and reliability. This will be accomplished through the addition of hydrogen to the natural gas fuel mixture.



Question 1: Relevance to overall DOE objectives

This project earned a score of **2.0** for its relevance to DOE objectives.

- Useful technologies have been developed for the transition to a hydrogen economy.
- This approach has low confidence in satisfying practical needs for fuel storage on large vehicles.
- Supportive of hydrogen fuels, but broad-based use of blends is uncertain.
- Barriers and relevance to DOE program not clearly articulated.
- Looks like the project is developing a product to be sold (a kit), not a research or validation project.
- This is a product engineering/development activity.

Question 2: Approach to performing the research and development

This project was rated **2.2** on its approach.

- Marginal benefits at best coupled with inadequate on board storage do not look attractive.
- Approach is successfully based on earlier hydrogen/natural gas blend R&D projects.
- Approach is very focused on producing a commercial product for sale.
- This project seems to fall somewhere between a combustion research project and a technology validation.
- Project objectives of converting engines to operation on hythane will be accomplished, but the barriers to the Hydrogen Initiative are not being addressed.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.8** based on accomplishments.

- Two products for 30% HCNG have been successfully developed.
- The accomplishments are impressive to date.
- Sound accomplishments, which indicate that this project is ready for commercialization and no longer an R&D activity.
- Would be helpful if results of project were put in context, such as being numerically compared to the 2007 emissions standards.
- Problems encountered during the project were not discussed: need to provide lessons learned for others in industry.
- Performer states on chart #2 that they are 0 complete; however, they appear to have a product ready for the market.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **2.2** for technology transfer and collaboration.

- Is there a business case to be made by any collaborators?
- Collier Technologies has now established a commercial partnership with Daewoo Heavy Industries- few partners otherwise.
- City of Las Vegas and Daewoo Heavy Industries were listed as partners, but nature of collaboration not clear.
- No evidence of any collaboration.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.0** for proposed future work.

- This niche application is now sufficiently evolved that DOE needs to let it go on its way.
- Looks like project has resulted in a successful product being developed.
- Future plans are for sale of the product devolved and no barriers are being addressed during or after this project.

Strengths and weaknesses

Strengths
- Developed a 30% HCNG conversion kit for light duty vehicles. Developed a dedicated 30% HCNG engine for the heavy duty engine market.
- Cleaner emissions are impressive.
- Collier Technologies have had a successful long-standing involvement in this technology.
- Focus on optimizing engine performance for emissions is good.
- Appears as though project resulted in product for market.
- Another hythane engine conversion will be available commercially.

Weaknesses
- Poster session was not presented.
- Getting enough fuel on board for adequate range will significantly reduce payload volume.
- Project did not compare progress to well defined metrics, such as emissions standards.
- Interaction with others outside Collier Technologies appears limited.
- Nothing about this project addressed barriers which must be overcome before the hydrogen economy can be realized.

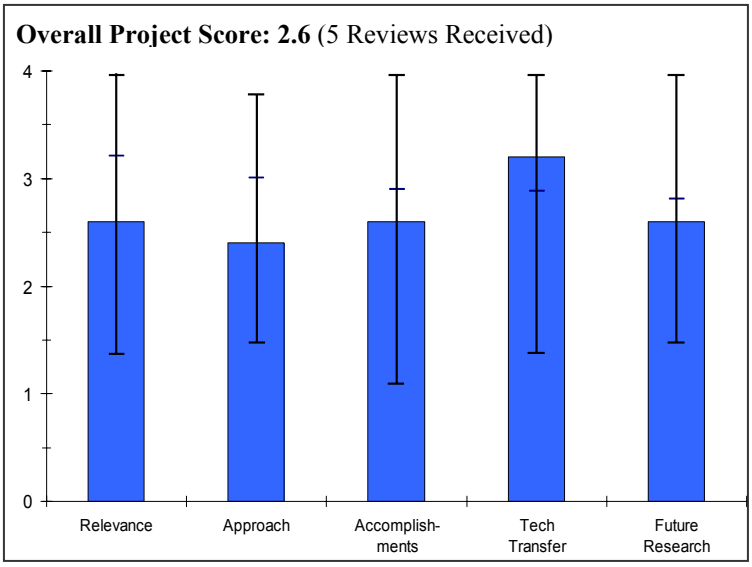
Specific recommendations and additions or deletions to the work scope

- Delete the project unless fuel storage is addressed with a credible proposal.
- Further funding is of questionable value for DOE's hydrogen and fuel cell R&D programs.
- Focus on perfecting product for marketplace.
- Demonstrate and document clear emission, efficiency, and other benefits (as compared to alternatives) so that they may be evaluated.
- Note: Poster was not "posted" so this review was performed from slides provided before conference. This did not allow the normal personal interaction that is objective of posters.
- Federal research dollars should be focused on critical technology barriers.

Project # TVP-12: Fuel Cell Powered Underground Mine Loader Vehicle
Barnes, David; Vehicle Projects LLC

Brief Summary of Project

Vehicle Projects LLC is developing zero-emissions, 23 metric ton, 160 kW, fuel cell-battery hybrid mine loader. Three fuel cell stacks will provide 90 kW of continuous power. Nickel metal-hydride batteries will provide peak power as well as the ability to recover energy through regenerative braking. Hydrogen will be stored onboard as a metal-hydride. Vehicle Projects will evaluate the locomotive's safety and performance, primarily in surface tests, and evaluate its productivity in underground mines in Nevada and Ontario.



Question 1: Relevance to overall DOE objectives

This project earned a score of **2.6** for its relevance to DOE objectives.

- Good application.
- Mine loader is a poor application choice relative to HFCIT technology validation goals.
- Integration of early-technology hydride storage and fuel cell into heavy-duty off-road vehicle could provide useful data.
- Although this project supports a niche-market application, it has high value in addressing challenges of hydrogen storage and operational safety.
- Project is doing a good job of exploring market niches for fuel cell vehicles now, rather than having to wait for the costs to come down.
- This build and demonstration project will highlight technology shortfalls; however, most of those shortfalls are already known and can be demonstrated through existing models and laboratory experiments.

Question 2: Approach to performing the research and development

This project was rated **2.4** on its approach.

- Source of hydrogen?
- The technical approach is reasonable considering the poor (relative to HFCIT goals) vehicle application choice.
- The systems integration experience with this prototype vehicle will provide valuable 'lessons learned' for subsequent generations of mining equipment.
- Project involves large number of participants, and appears to be well organized from a project management perspective.
- Very little is being done to overcome critical barriers required to have affordable fuel cells available to transportation applications.
- This is an excellent packaging exercise; however, the technologies being used are very immature.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.6** based on accomplishments.

- The project has not yet accomplished much relative to the fraction of total project funds consumed.
- Although some compromises were necessary, the integration of the fuel cell power source and hydrogen storage have been successfully achieved.
- More detail should be provided on technical accomplishments: lots of technical specifications were provided on the various components, but more detail on what has been accomplished should be provided.
- This team is making reasonable progress toward demonstrating that a fuel cell vehicle can be assembled.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.2** for technology transfer and collaboration.

- Great collaboration.
- Collaboration does not appear to extend beyond project participants.
- Excellent relationships established with Caterpillar, Hera and other partners.
- Looks like good interactions with other companies (under subcontract), but not sure how much interaction is taking place with others outside of the project.
- This is an excellent example of qualified, well integrated manufacturing team; however, this team falls very short on research capability.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.6** for proposed future work.

- Unlikely to finish project as planned within budget.
- The next generation vehicle should be an excellent example of the benefits of fuel cells and hydrogen as a safe, emission-free power train for critical environment operations i.e. mines.
- Plans for future work look reasonable, although more detail could be provided.
- Future activities will highlight that technical barriers do exist; however, these activities will do little to overcome those barriers.

Strengths and weaknesses

Strengths
- Well thought out plan and great collaboration.
- Ambitious integration of hydride storage and fuel cell on specialized off-road vehicle.
- Sound systems engineering expertise in supporting this project.
- Well organized project with clear responsibilities for all parties involved.
- Appears to be making significant progress within relatively short timeframe.
- Well integrated manufacturing team with reasonable cost share.

Weaknesses
- Source of hydrogen (and effects) not included.
- Application is poor fit with HFCIT program technology validation goals.
- Technical progress rate significantly lags project funds consumption rate.
- Can 'lessons learned' from this special application vehicle project be of use to conventional vehicles?
- Need to show how lessons learned from this very specific market niche could be applied to other applications (for example, light-duty automotive vehicles).
- Very little activity directed toward research to overcome technology barriers.

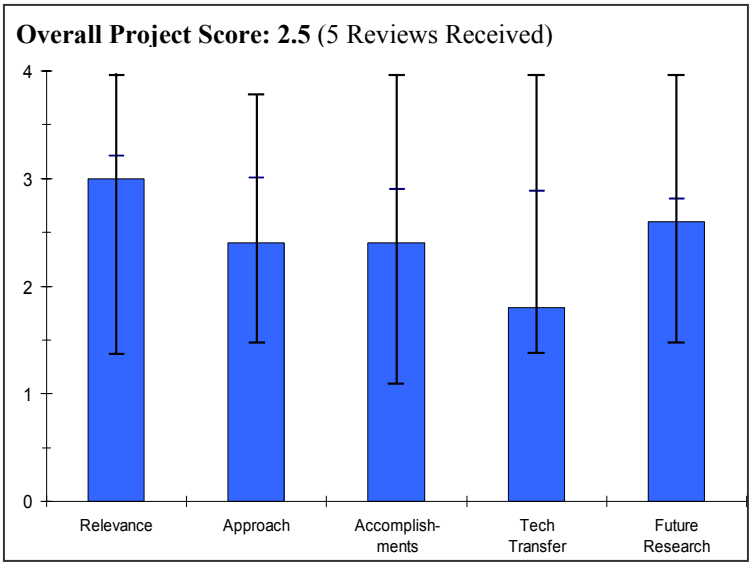
Specific recommendations and additions or deletions to the work scope

- Investigate on-site hydrogen sources.
- Re-plan project for graceful completion without additional funding.
- Only one more development generation of this vehicle is justified. Thereafter commercial viability should be achieved.
- Upon completion of project, write an NHA or SAE paper on the lessons learned and technical performance achieved from this project.
- Efforts need to be put in place to assure that performance, reliability, durability, operability, etc. data are collected and made available.

Project # TVP-14: Hydrogen Transition Infrastructure Analysis
Melendez, Margo; National Renewable Energy Laboratory

Brief Summary of Project

The National Renewable Energy Laboratory (NREL) infrastructure development analysis seeks to understand the benefits and drawbacks of various options for installing hardware for a developing hydrogen demand. Work focuses on the combination of spatial and temporal assessments, to identify the most economic pathways for successfully meeting emerging hydrogen demands. Hydrogen infrastructure transition analysis identifies, describes, and quantifies options for hydrogen refueling during the transition to hydrogen as a transportation fuel.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.0** for its relevance to DOE objectives.

- Hydrogen as a transportation fuel in the context of GIS seems supportive of transportation orientation.
- Relevance high for actual hydrogen implementation but this is a little too academic and theoretical.
- This project addresses long-range HFCIT goals involving Systems Analysis and System Integration.
- This project is important if it was felt that DOE needed independent data on the build out of hydrogen fueling stations, but the industry might have provided enough of this information to have made educated estimates of the results without the expenditure of federal research funds. Look at the publicly created results for the California hydrogen highway.
- The results are important only if the federal government is going to direct or substantially pay for the fueling infrastructure. This is unlikely in this market environment.
- An industry analysis would be more credible.

Question 2: Approach to performing the research and development

This project was rated **2.4** on its approach.

- Correlation in GIS environment. Should consider including pipelines and commercial hydrogen resource locator.
- Focus is lacking. Too many mandated assumptions like driving patterns and distances.
- Alternative storage methods not considered.
- Focus is only on interstates- not adequate.
- Approach should give more emphasis to lessons learned from prior alternative fuel infrastructure experience.
- Approach should give more emphasis to hydrogen transition infrastructure strategy.
- Approach should give less emphasis to specific geographic locations.
- The approach is appropriately analytical with good data and assumptions.
- The regional approach, with fleet data, seems inconsistent unless the fleet data excludes the local fleets.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.4** based on accomplishments.

- 284 stations along major interstates minimum to achieve national coverage - $1 billion.
- Has just made some assumptions but hasn't validated anything yet.
- Seems superficial to date.
- Good progress relative to funds expended.
- Nice application of GIS.
- The results are clear and should be considered useful.
- The build-out of the fueling infrastructure is important but industry has said this is not a critical barrier, at least at this time.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **1.8** for technology transfer and collaboration.

- Analytical results. The communications with stakeholders not addressed.
- Doesn't look like many outsiders were consulted, i.e. vehicle teams, GM, Shell, etc.
- Auto companies should be included.
- Good H2A collaboration.
- The collaboration with industry is not evident.
- The data may guide DOE but it is unlikely to influence other decision makers.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.6** for proposed future work.

- More detailed info at end position. Connect to feedstock sources.
- Needs to focus on barriers to establishing a network of refueling stations.
- Planned transition strategy development will be very important.
- The future research indicates important questions, but they are largely marketplace questions that require marketplace answers.

Strengths and weaknesses

Strengths
- Good presentation.
- Good access to lots of data.
- Starts to address very important issues associated with any hydrogen infrastructure initiation.
- Good collaboration with H2A.
- An analytical approach to estimating the magnitude of the build out of the infrastructure will be important to some decision makers.

Weaknesses
- Stakeholder usability was not addressed. Seem isolated from many state projects.
- Too theoretical and not realistic. Assumes government driven rather than industry and economics.
- Looks only at interstate highways.
- Looks only at compressed hydrogen.
- Needs collaboration with auto companies.
- Should have developed input from potential station owners/investors sooner.
- The study has credibility only if those that have been making decisions on building fueling stations are involved directly in this study.

Specific recommendations and additions or deletions to the work scope

- Address weaknesses.
- Collaborate with existing gasoline infrastructure participants. Collaborate with other refueling projects.
- Correct weaknesses.
- Continue as planned.
- Develop input from potential station owners/investors to support strategy development.
- Subject this study to an independent industry review team to provide credibility. Then the results will be more useful to decision makers.