2008
Technology Validation
Summary of Annual Merit Review Technology Validation Subprogram

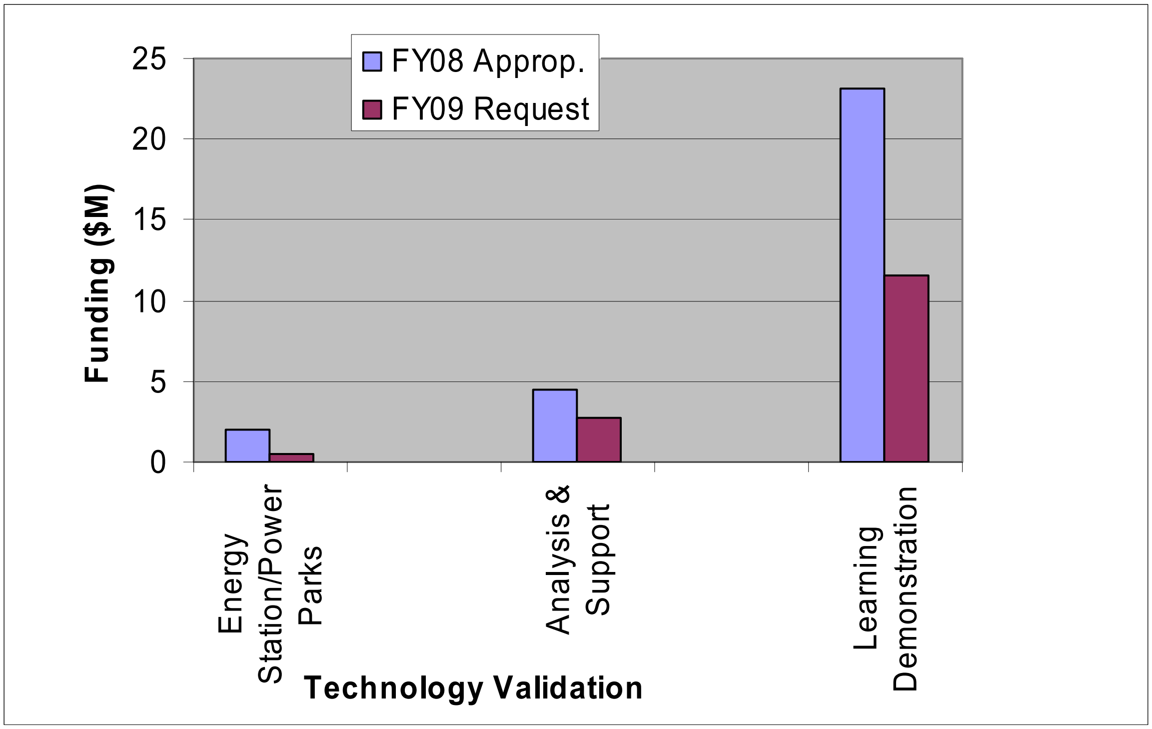
Summary of Reviewer Comments on Technology Validation Subprogram:

Reviewers consider the learning demonstration project to be a key element in determining whether the program's hydrogen and fuel cell activities are on course to achieve established research and development targets. In addition, acquiring "real world" operational data and experience is vital to making appropriate adjustments to the hydrogen program's research and development projects. Infrastructure demonstration elements provide hydrogen and validate fueling technology performance. There has been good progress in opening stations and putting vehicles on the road. Significant vehicle miles and hours are being accumulated on the vehicles in the learning demonstration. Codes and standards work is a very important aspect of technology validation and educational outreach to the public is an enhancement to the learning demonstration.

Reviewers thought that generation 2 vehicles have taken longer to deploy than the schedule might support and that the schedule should be analyzed. Insufficient effort is being made to maximize loading of hydrogen stations. However, an integrated electricity and hydrogen production facility is an innovative concept and promises to encourage the use of hydrogen fueling stations even when the vehicle usage might be low, at the start of deployment**.**

Technology Validation Funding by Technology:

The funding portfolio for Technology Validation stresses the continuation of the 6 year Learning Demonstration project as it enters its fifth year. Second generation vehicles will continue to be operated and data collection next year will provide information on meeting 2009 fuel cell durability and vehicle range targets. A high temperature fuel cell energy station will be funded and constructed in 2009 followed by a 6 month demonstration of the system. The FY2009 funding profile is subject to Congressional Appropriations. In FY 2009 the Technology Validation Activity is being transferred to the Vehicle Technology Program from the Hydrogen Program.



Majority of Reviewer Comments and Recommendations:

The Reviewer scores for the Technology Validation Subprogram were a maximum of 3.7, minimum of 2.5 with an average score of 3.2. The major recommendations by reviewers are presented below for each of the task areas. DOE will act on reviewer recommendations as appropriate for the overall Hydrogen Technology Validation effort.

- **Learning Demonstrations –** The project is an important effort to demonstrate the feasibility of fuel cell vehicles and hydrogen infrastructure. Technology Validation project teams should work together on ways to take advantage of the technology validation infrastructure investments after the projects are completed.

- **Energy Stations –** The integrated electricity and hydrogen production facility is an innovative concept and allows the use of hydrogen fueling stations even when the vehicle usage might be low, at the start of deployment.

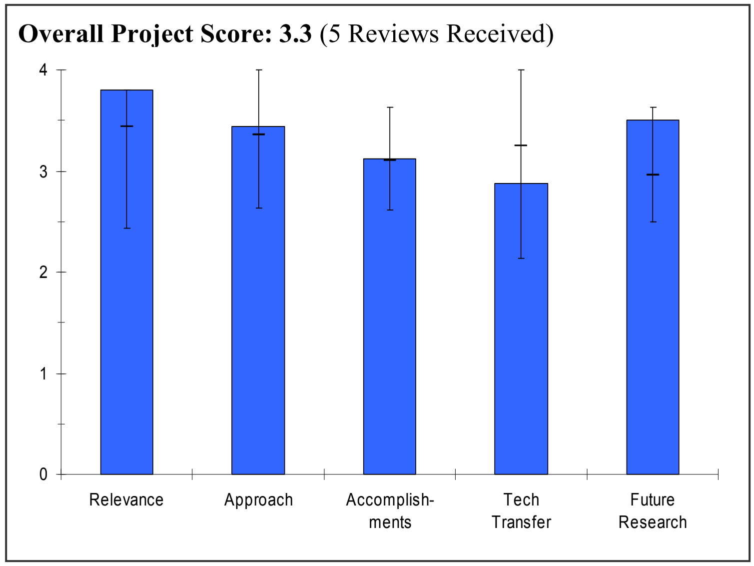
- **Storage –** The project focuses on one of the Department of Energy's key objectives which is to improve on-board hydrogen storage options available to the OEMs. Storage system should be better packaged in the vehicle so they do not intrude into passenger and cargo area.

- **Analyses –** These projects are vital to determining whether the Program's hydrogen and fuel cell activities are on course to achieve established research and development targets**.**

Project # TV-01: Hydrogen to the Highways
Ron Grasman; DaimlerChrysler

Brief Summary of Project

The main focus of the on-going Department of Energy (DOE) Fleet Validation and Demonstration Project is to collect data and evaluate the technology status of: fuel cell-powered vehicles (original equipment manufacturers) and hydrogen infrastructure (energy companies and suppliers); and validate DOE 2009 performance targets including 250-mile vehicle range, 2,000-hour fuel cell durability, $3.00/gasoline gallon equivalent production cost.



Question 1: Relevance to overall DOE objectives

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

- This project is a key element in determining whether the program's hydrogen and fuel cell activities are on course to achieve established research and development targets.
- Acquiring "real world" operational data and experience is vital to making appropriate adjustments to the hydrogen program's research and development project mix and specific projects.
- This project is generating significant operational data.
- Project addresses Department of Energy needs and barriers in a general manner.
- Hard to evaluate the technical side of this from the presentation.
- This kind of information is critical to guide the more technical Research part of the program.
- Validation of hydrogen fuel cell vehicles in real world condition is clearly relevant to DOE objectives.
- This project is to drive and document progress in the next generation of fuel cell vehicles.
- Demonstration vehicles are critical for advancement of the technology.
- Deployment to varying climate areas is a good enhancement.

Question 2: Approach to performing the research and development

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

- The primary element of a multi-dimensional approach is operation of Generation I and II hydrogen-fueled vehicles, with collection of detailed data sufficient to enable monitoring of performance relative to program targets.
- Infrastructure demonstration elements provide hydrogen and validate fueling technology performance.
- Safety initiatives have a high priority.
- Public education and awareness are also built into the project's activities.
- The point was made that detailed data are being generated for corporate use, in addition to that being provided to the National Renewable Energy Laboratory.
- This is not research, rather it is technical and product evaluation/marketing.
- The approach to the work appears adequate although there does not seem to be any major focuses on stressing systems to failure. This would be very useful from a safety point of view.
- Real world data acquisition is clearly the right way to validate hydrogen fuel cell vehicles, although it is unclear from the report what data is being collected.
- Codes and standards work is a very important aspect of technology validation.
- Good coordination with first-responders, including a fire vehicle.

- Public and educational outreach is an enhancement.
- Standards efforts are good.
- Government fleets might be an improvement.

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

This project was rated **3.1** based on accomplishments.

- An impressive listing of accomplishments was presented.
- Accomplishments include upgrading of the Gen-I fuel tank system to 70 MPa, and optimization of the vehicle software algorithm.
- Extensive support has been provided for safety codes and standards activities involving standards development and other organizations.
- The project's safety initiatives include "table top" crisis management exercises.
- Outreach and media events were detailed in the presentation.
- Since this project is not really research, this is an unfair assessment. The technical barriers are indistinct. However, the barriers to be overcome are the accumulation of product information to guide future research investment. The approach could be harsher, that is running the systems closer to performance limits could accelerate gathering of failure information that would be useful.
- Optimized software to improve fuel efficiency. This is why this project is important.
- 70 MPa storage on the vehicle.
- Codes and standards documentation, such as the best practices manual, is an important output of this program.
- Project was conducted in a safe manner, without incident.
- Vehicle numbers have met goals.
- Vehicle fueling stations are being open to support planned deployments.
- HAZOP approach is exemplary.
- It seems like the Generation II vehicles should have been deployed already. The schedule should be analyzed.

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

This project was rated **2.9** for technology transfer and collaboration.

- The project team is fully engaged with many organizations addressing safety, and codes and standards, issues.
- Significant partnering and collaboration with government agencies, the media, and other organizations have enhanced the quality and results of outreach and education activities.
- There was no elaboration on how the project's primary partners are coordinating their activities.
- Co-ordination comes from Daimler plus Chrysler— this is weak.
- Performance data submitted to NREL.
- Detroit Edison Energy, NextEnergy, BP provide fueling stations for project.
- The program has good coordination relationships with various agencies and companies. This is a strength.
- Additional use by government fleets might be an improvement.
- The program seems to take full credit for standards released by CSA, SAE, ASTM, ICC and the DOE program in general. Although support by Daimler and Chrysler is certainly a factor in the release of these standards, dozens, if not hundreds, of additional experts from other corporations and other agencies were involved in the release of these standards. Taking full credit seems to be overstating the contribution of the contract.

Question 5: Approach to and relevance of proposed future research

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

- Plans for future work were well summarized and clearly presented.
- Not sure what Generation II vehicles and improvements are.
- Lifetime test of Generation II fuel cell on test bench.
- Generation I vehicles continued to be tested by customers.

- Internal testing of Generation II vehicles for durability under different climate conditions.
- Daimler will continue their vehicle testing program and their cooperation with NREL and the technical evaluation assigned to NREL.
- The build-up to the release of Generation II vehicles is perhaps slower than the schedule might have supported. The schedule should be analyzed.
- The future planning seems consistent with the tasks remaining to be accomplished.

Strengths and weaknesses

Strengths
- Significant vehicle miles and hours are being accumulated.
- Generation II vehicles are showing promise of significant improvement. There seems to be good utilization of the experience and knowledge gained from operations earlier in the project.
- Safety and outreach activities are important elements of the project.
- Experience is being gained in dealing with a variety of infrastructure issues.
- Reasonable number of vehicles involved. More would be better.
- Demonstrating technology status, developing codes and standards documentation, public outreach.
- Generation I vehicles were out early and have led the deployments of others, showing commitment and optimistic deployment of the technology.
- Good coordination with user agencies and hydrogen suppliers.
- HAZOP analysis is exemplary.
- Coordinating refueling stations is exemplary.

Weaknesses
- Generation II improvements are vague.
- Failure scenarios not pushed.
- It seems that hydrogen storage and fuel cells are being fit into a traditional car. Any plans to design the car form specifically for the fuel cell and hydrogen storage?
- It is unclear whether cost is a consideration when implementing the fuel cell and storage system into the vehicle.
- Quantified performance results not shown.
- The project might have benefitted from additional government fleet use.
- The project tends to take credit for standards that required an entire industry to develop. This might be better clarified.
- Generation II vehicles have taken longer to deploy than the schedule might support. The schedule should be analyzed.

Specific recommendations and additions or deletions to the work scope

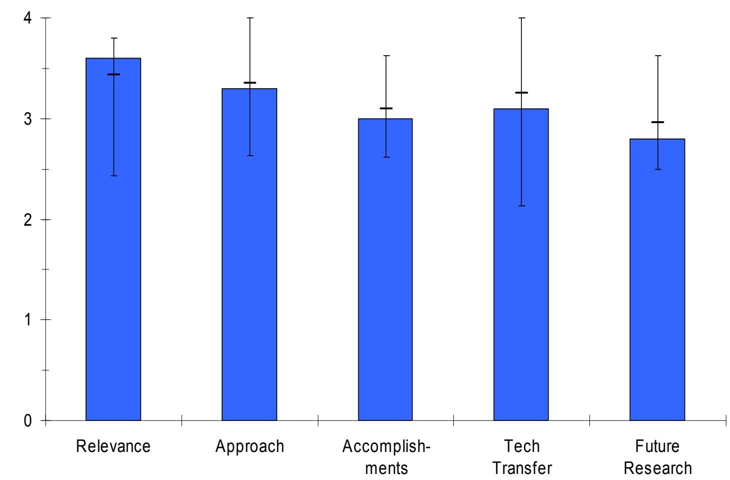
- It was stated that a project extension through September 2010 is being considered. While no addition to the project scope is recommended at this time, it is appropriate for DOE, this project team, and the other technology validation project teams to work on ways to take advantage of the technology validation infrastructure investments after the projects are completed.
- Add more "push to failure" scenarios. Lifetime durability acceleration schemes.
- Show system weight and volume specifications compared with DOE targets.
- Adding vehicles to government fleets might be able to better demonstrate the technology to early adopter markets.
- Accelerating the deployment of Generation II vehicles would be encouraged to keep up the momentum demonstrated by DaimlerChrysler during the Generation I deployments.

Project # TV-02: Hydrogen Fuel Cell Vehicle and Infrastructure Demonstration Program Review
Greg Frenette; Ford

Brief Summary of Project

The objective of this project is to gain fuel cell vehicle operational data in differing climate conditions to direct and augment future design efforts. Objectives since the last review have been to 1) continue phase I vehicle operation; 2) report operational data; 3) maintain fleet; 4) survey customers; and 5) investigate updated concept vehicles and demonstration.

Overall Project Score: 3.2 (5 Reviews Received)



Question 1: Relevance to overall DOE objectives

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

- This project has direct relevance to the Department of Energy's Multi-Year Program Plan and will help DOE achieve its goals.
- Based on National Strategic goals, the project supports National energy goals.
- The program appears to meet comprehensive hydrogen and fuel cell program goals including scope of deployment.
- It is extremely relevant to have major OEMs such as Ford involved in vehicle/infrastructure validation activities.
- Both the vehicle and infrastructure portions of the project predominantly support the Hydrogen Fuel Initiative and goals of the Multi-Year Program Plan.
- This project is relevant to the Hydrogen Fuel Initiative; however, its cost to DOE is very significant.

Question 2: Approach to performing the research and development

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

- Approach has not changed for both the vehicles and the infrastructure.
- The addition of a new location and a new hybrid vehicle are good additions and will enhance the approach.
- Applicant is clearly focused on overcoming technical barriers especially with respect to cold weather operations and onboard storage.
- There was very little discussion of teaming partners or expansion plans!
- Ford is providing vehicles and working with appropriate partners to provide potentially very valuable validation information. Unfortunately, very little detail was presented.
- Approach is conventional and targets principal barriers at the vehicle and infrastructure level.
- BP seems fully committed to safety of H_2 infrastructure.
- Number of vehicles involved (18) seems low for project of this magnitude. Unclear as to whether statistically valid sample sizes will be achieved.
- It is not overtly clear that strong efforts are being made to maximize the loading of the H_2 stations. No discussion of coordination with other entities to use these facilities for transportation (i.e. Hydrogen fueled internal combustion engine vehicles) or stationary H_2 applications.
- Approach used is as in similar tech validation projects; it has not changed since last year.
- Variation of geographic regions, in particular the latest addition of Iceland, is a plus.
- Impact of this project on advancing fuel cell technology for automotive applications is not obvious.

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

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

- Added a 4th geographic region, Reykjavik, Iceland with a cooler climate. This will help analyze the fuel cells operation in a colder climate.
- Automated data collection takes into account the new HyWay 2/3 technology or next generation vehicle design.
- This project has many successes on the operation of the vehicle and supporting infrastructure.
- Flexible Series Hybrid data collection using the auxiliary power unit.
- Significant success on the infrastructure, i.e., Sacramento Municipal Utility District station.
- The applicant clearly presented that barriers existed but little was actually presented about scope of barriers or how they will be resolved.
- There was virtually no quantitative information presented so there is no way to determine the value of the efforts.
- It appears that relatively little effort went into developing the presentation.
- Information is high level making it difficult to fully assess technical progress. Side-by-side comparison of key project milestones and associated technical progress is not provided.
- Little data is provided on technical and cost targets achieved leading to questions with regards to transparency.
- Progress appears to have been made with respect to 700 bar refueling and storage systems and fuel cell stack beginning of life power requirements, sub freezing start-up, and lifetime.
- Project appears to be a continuation of previous effort, with relatively few modifications.
- Very little technical information makes accomplishments and progress difficult to judge independently, forcing reviewer to fully rely on rather general statements included in the presentation.

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

This project was rated **3.1** for technology transfer and collaboration.

- This project has excellent collaboration with others.
- The project team was creative in its support for placing a vehicle in Iceland and mentioned that they had partners, but offered little discussion on the roles of those partners or whom their collaboration efforts were with.
- There appears to be excellent potential for collaborations, but there was little mention of actual interactions or information transfer except with energy partner, BP.
- Little mention of technology collaboration or transfer. Nature of project may preclude this at this point however it seems conceivable that collaboration with national laboratories/universities may facilitate solutions to stickier technical problems with regards to H_2 storage etc.
- Would be beneficial if information from this project could be shared with manufacturers of medium/heavy duty commercial vehicles such as buses. These applications are more likely in the near term and could benefit from lessons learned with H_2 light duty vehicles.
- Good collaboration with BP; role of other partners unclear.

Question 5: Approach to and relevance of proposed future research

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

- This project will redefine Phase II vehicle configurations and complete the 700 bar station.
- The presentation appeared thorough in its presentation of where Ford was and is, but appeared weak on future development and/or expansion plans.
- Even though little detail was given, the continuation of, and expansion of (with a new generation vehicle and 700 bar hydrogen), present efforts is very important.
- Plans exist for working toward near term commercialization opportunities for H_2 vehicles (curbside, people mover, etc.).

- Further discussion indicated it is expected some of the refueling stations would remain operational after sunset of project, but no details were provided. Every effort should be made to keep all the refueling facilities open in some capacity even if their scope would require alteration.
- No major modifications to the project are anticipated.
- Little innovation.

Strengths and weaknesses

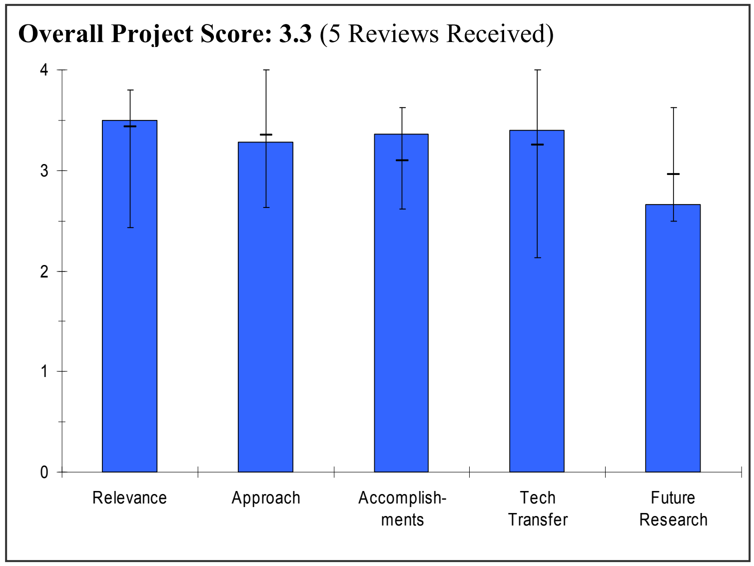
Strengths
- Excellent management.
- Bringing a test vehicle to Iceland and obtaining DOE permission to locate a vehicle in Iceland goes a long way to further international deployment.
- Applicant's location of test sites across the nation, and in a variety of climates, is noteworthy.
- Ford and partners are major players with enormous combined capabilities.
- Addresses strong need for demonstration and evaluation information on H_2 vehicles and infrastructure.
- Convincing and thorough summary of "limiting issues."

Weaknesses
- None.
- The presentation did not adequately discuss their partners and the roles of those partners.
- There was no presentation on "What's next," specifically, how the program is to be developed from current state.
- The lack of detail in the presentation suggests the possibility that the project could have relatively low priority.
- Project seems somewhat stove piped and insular (Ford - vehicles, BP- H_2 fuel) with little outside collaboration or technology transfer.
- Given scope of project, number of vehicles and refueling stations seems limited.
- Insufficient effort is being made to innovatively maximize loading of H_2 stations.
- Below-target mileage accumulation is a drawback.
- There is little indication that this project will have an impact on overcoming challenges facing to fuel cell technology.
- Little technical content.
- Number of vehicles could be more in this project.

Specific recommendations and additions or deletions to the work scope

- Economic viability should be determined if possible for both vehicles and infrastructure.
- Develop the roles of your team members.
- Advise on the growth of the next step in deployment.
- Expand and enhance the technical discussion in the presentation.
- Include at least minimal quantitative information in future presentations.
- Propose specific approaches to identify some of the real-world adverse effects of normal operation.
- Fewer photos and more technical information would make this and similar technology validation presentations more useful to the community.

Project # TV-03: Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project
Dan Casey; Chevron



Brief Summary of Project

Objectives for this project are to 1) demonstrate complete systems of integrated hydrogen fuel cell technologies for transportation and hydrogen infrastructure under real-world operating conditions; and 2) validate DOE 2009 performance targets including 250-mile vehicle range, 2,000-hour fuel cell durability, $3.00/gasoline gallon equivalent production cost, and safe and convenient refueling by drivers.

Question 1: Relevance to overall DOE objectives

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

- This project is a key element in determining whether the program's hydrogen and fuel cell activities are on course to achievement of established research and development targets.
- Acquiring "real world" operational data and experience is vital to making appropriate adjustments to the hydrogen program's research and development project mix and specific projects.
- This project is generating significant operational data.
- Addresses Department of Energy goals and objectives.
- The Department, in partnership with industry, is demonstrating contemporary fuel cell vehicle technology, and the hydrogen fuel infrastructure that supports those vehicles. This project is part of that activity.
- Refueling stations are essential to the program.
- Vehicle deployments are essential to the program.
- Hydrogen and electricity co-production is an innovative approach to meeting load factor needs of fueling stations.
- Like other similarly scoped technology validation projects in this group, this project is relevant to the hydrogen fuel initiative but does relatively little to identify major technical challenges still facing fuel cell technology.

Question 2: Approach to performing the research and development

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

- The slide addressing project approach was general and not particularly informative.
- Discussion of the approach by Mr. Casey was also brief and limited.
- Like to see some "push to failure" experiments - cold temperature examples given are good. Like to see more.
- Lessons learned from vehicle accident are examples of "push to failure" benefits. Try to design "accidents" into the project.
- Hydrogen and electricity co-production is an innovative approach to meeting load factor needs of early fueling stations.
- Including data from the Orlando station without cost to the DOE program is an enhancement.
- Diverse driving patterns are strengths.
- Relatively high number of tested vehicles is a plus; little technical information is a minus.

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

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

- Year-to-year progress was shown for deployment of vehicles. 29 vehicles are now deployed.
- The data transfer and collection system has been upgraded, conveying impressive performance on this aspect of the project.
- Progress has been made on varied infrastructure development and utilization. Experience is being gained in dealing with multiple fueling station options and issues.
- Vehicles are being driven by a variety of operators, and used for a variety of purposes.
- Second generation vehicles have 700 bar tanks and supercapacitors for improved range and performance.
- Opened stations and vehicles are on the road. Significant progress.
- This is not research but product evaluation - good work in this respect.
- Good explanation of how the data is collected and analyzed by the Project and the National Renewable Energy Laboratory.
- Responded to reviewer comments from before re driver diversity.
- Explained Generation I to Generation II improvements.
- High pressure (700 bar) fueling hardware is being commissioned for the latest vehicles in the US fleet.
- Retraining of first-responders is a good improvement.
- Good analysis of "full fill" issue.
- Full deployment of vehicles and stations appears to be lagging behind what the schedule might have supported. The schedule should be analyzed.
- Interesting analysis of temperature effects during fueling.
- Technical progress difficult to assess due to very limited technical content of the presentation (not unusual for tech validation projects in general).

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

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

- Work has been undertaken in collaboration with Gas Technology Institute on technology for co-production of hydrogen and electricity.
- Discussions are being undertaken with host sites about keeping fueling stations in operation after completion of the project.
- There was no discussion during the presentation about technology transfer initiatives, other than to point out that a case study had been done following a vehicle accident and that lessons learned from the project (e.g., station permitting and first responder re-training experience) was being communicated during the merit review.
- Seems to be adequate coordination between the partners and NREL.
- Chevron works with a group of excellent companies, a group of individuals who are operating, fueling, and evaluating the fuel cell vehicles. Chevron is also working with NREL, and with NREL's fuel cell vehicle testing program.
- Good coordination with other associations.
- Co-production of electricity and hydrogen is an innovation and inclusion is a strength.
- Strong partners with mutually complementary expertise.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.7** for proposed future work.

- There was minimal discussion of future work plans, focus and priorities.
- Future plans are not very exciting.
- The plan is to continue this activity until the next generation of fuel cell vehicles are thoroughly evaluated.
- Planning for future work appears to be limited. This is an area where additional effort might yield significant results.
- Continuation of the present effort; creativity & novelty are both missing.

Strengths and weaknesses

Strengths
- Significant vehicle miles and hours are being accumulated.
- The second generation of vehicles promises substantial improvement. There seems to be good utilization of the experience and knowledge gained from operations earlier in the project.
- Advancements in data gathering and transfer.
- Ability to work with host sites to install fueling stations with varied technologies, to provide a broad base of experience and information for comparison purposes.
- Good progress in opening stations and putting vehicles on the road.
- Lessons learned are good. Should be built upon.
- Good coordination.
- Electricity and hydrogen co-production.
- Almost all vehicles and stations have been deployed.
- Higher number of vehicles than in some other technology validation projects.

Weaknesses
- There is little evidence that education and outreach are important elements of this project.
- Other than brief discussion of a vehicle accident outcome, there was little or no mention of safety initiatives, activities, and contributions related to this project.
- Future plans are weak.
- Not all vehicles and stations have been deployed yet.
- Planning for future work seems to be lacking.
- Expensive. No obvious value to overcoming major technical challenges facing fuel cell power systems.

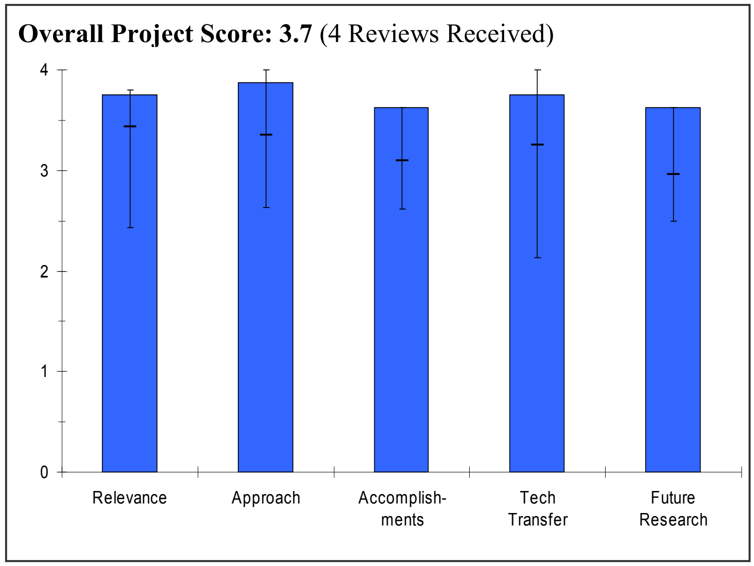
Specific recommendations and additions or deletions to the work scope

- While no addition to the project scope is recommended at this time, it is appropriate for DOE, this project team, and the other technology validation project teams to work together on ways to take advantage of the technology validation infrastructure investments after the projects are completed.
- Add future plans with more detail.
- It would be interesting to assign a test vehicle to a "car" magazine (such as Road and Track), and let a "wrench" (an automobile enthusiast) drive and write about one of the test vehicles.
- Additional planning for future work might yield significant results.

Project # TV-04: Hydrogen Vehicle and Infrastructure Demonstration and Validation
Roz Sell; General Motors

Brief Summary of Project

General Motors and energy partner Shell Hydrogen are deploying a system of hydrogen fuel cell electric vehicles integrated with a hydrogen refueling infrastructure to operate under real world conditions. The objectives of this project are to 1) demonstrate progressive generations of fuel cell system technology; 2) demonstrate multiple approaches to hydrogen generation and delivery for vehicle refueling; and 3) collect and report operating data.



Question 1: Relevance to overall DOE objectives

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

- The project expects to meet all of the Department of Energy goals in a timely manner.
- The DOE technical targets will remain the same in spite of the extension for this project.
- The project fully supports the President's Hydrogen Initiative and it is critical to the Hydrogen Initiative
- The General Motors project meets both technical and education goals.
- Very relevant to have major OEMs such as GM and appropriate partners involved in validation programs.
- This project strongly supports the Hydrogen Fuel Initiative and the technology validation aspects of the Multi-Year Program Plan for vehicle and infrastructure demonstration and evaluation.

Question 2: Approach to performing the research and development

This project was rated **3.9** on its approach.

- GM has extended this project in order to match DOE funding and to add second generation vehicles and increase the number of refueling stations.
- Phase 2 has started now with plans for 40 vehicles (Chevrolet Equinox).
- The General Motors program is working to address current and technical challenges, as well as the challenges to increasing fuel cell vehicle production.
- Both intent and execution of approach are excellent.
- The approach is well-developed, outlined, and targeted to barriers. Especially appealing is the fairly large number of vehicles (40) and refueling sites (5) being evaluated for DOE and attitude of open access where possible to the refueling sites.
- The project is also taking an aggressive posture with respect to vehicle demonstration and evaluation involving various government and private entities and citizens (Project Driveway), as well as public relations. The "driver relationship managers" is a proactive step to facilitate customers H_2 vehicle experience.
- The approach for H_2 station permitting is also strong emphasizing data collection and open access to a database of codes and standards, lessons learned, and processes to facilitate site permitting.

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

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

- This project successfully completed phase 1.
- Virgin Atlantic has partnered with GM to test vehicles at the Los Angeles airport.
- Commercial station with 700 bar refueling will be available this year at Benning road.
- Maintenance and training facilities are excellent additions to this project.
- They have purchased six 700 bar mobile refuelers to assist the customer on quick fills.
- The General Motor's presentation well-discussed fuel cell technical barriers, data collection, and ancillary technological requirements.
- General Motors has often raised concerns about hydrogen station quantity, location, and other concerns but they made clear that they are working to resolve.
- Overall the accomplishments are excellent and impressive. However, apparently relatively little was accomplished in the past year.
- Technical progress is somewhat more difficult to assess with respect to the vehicles due to the lack of a side-by-side comparison of targeted milestones and progress achieved.
- Progress is more clearly ascertained with respect to the fueling stations and appears to be on schedule.
- Overall, the task is making significant progress and is on schedule (or ahead) for completion.
- There is little mention of specific technical performance data (efficiency, life, cost, etc.).

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

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

- Feedback from customers is essential.
- Infrastructure is essential and they need to collaborate with DOE to support this work.
- The presentation made it clear that General Motors greatly values all of its team members, partners, and customers.
- The General Motors team is demonstrating great creativity in bringing the technology to the public.
- From the presentation, it appears that collaborations and information transfers are excellent.
- Project has extensive list of partners especially with respect to the user demonstration component.
- There is no mention of outside collaboration with other projects or non-participating industrial or academic institutions.
- Project should in future consider technology transfer agreements with non competitive entities in the commercial heavy duty vehicle sector (i.e. buses).

Question 5: Approach to and relevance of proposed future research

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

- Deploy Phase 2 vehicles and inaugurate more stations.
- 700 bar fast-fill refueling is needed.
- GM is providing access for all automotive companies and their customers to this project's refueling stations.
- The presenter made it clear that General Motors current effort is built upon a large body of early work and that this current effort is the foundation for newer consumer products.
- Generally very good but no apparent plans to pursue any specific problem areas.
- Future work implies commitment to reaching the next level of hydrogen vehicle and refueling station deployment and utilization. No specific mention is made, however, of plans for hydrogen refueling facilities at the conclusion of project.
- Project is laying groundwork to significantly facilitate hydrogen refueling station permitting in the future.

Strengths and weaknesses

Strengths
- This project has excellent collaboration with other companies.
- Ms. Sell's presentation was very comprehensive and balanced.
- GM and partners represent a very formidable combined capability.

- GM projects genuine enthusiasm for the project.
- Overall, relatively strong project clearly focused on technology validation barriers for H2 vehicles and refueling.
- Especially refreshing is the wide demonstration partner aspects of the project, public relations, and open mentality toward knowledge transfer on lessons learned and processes for hydrogen refueling codes and standards and permitting.

Weaknesses

- None.
- The General Motors presentation was perfect until the slide that brought up ethanol.
- None of significance.
- No mention is made of near term commercial applications of hydrogen vehicle technology such as people movers, trams, etc.

Specific recommendations and additions or deletions to the work scope

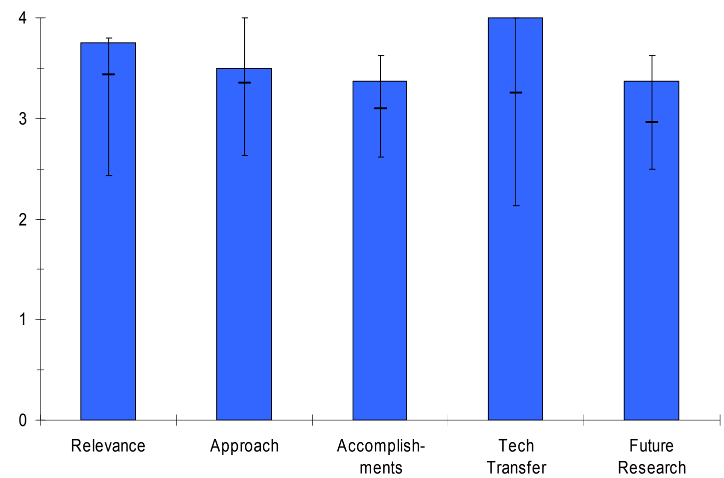
- Use the experience of the other 60 vehicles that do not collect data as part of this project.
- The General Motors presentation should delete references to ethanol unless they are addressing farmers.
- Put some effort into planning follow-up for the more severe problem areas encountered associated with vehicle/infrastructure.
- Add vehicle component targeting potential near term niche applications.

Project # TV-05: Controlled Hydrogen Fleet and Infrastructure Analysis
Keith Wipke; NREL

Brief Summary of Project

The objectives of this project are to 1) validate H_2 fuel cell vehicles and infrastructure in parallel; and 2) identify the current status and evolution of the technology including assessing progress toward technology readiness and providing feedback to H_2 research and development. Key targets are for a fuel stack durability of 2,000 hours, vehicle range of at least 250 miles, and hydrogen cost at station of $3/gasoline gallon equivalent (gge) by 2009.

Overall Project Score: 3.5 (4 Reviews Received)



Question 1: Relevance to overall DOE objectives

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

- This project provides important and necessary end-user data and operating experience. Results should be used to provide future Department of Energy direction and emphasis and identification of technical areas that require additional and/or expanded emphasis.
- This project is considered to be the most important and critical element of the Technology Validation Sub-program, which receives a significant portion of DOE's Hydrogen Program funds.
- Acquiring "real world" operational data and experience is vital to making appropriate adjustments to the Hydrogen Program's research and development project mix and specific projects.
- This project is vital to determining whether the Program's hydrogen and fuel cell activities are on course to achieve established research and development targets. Without it, there would not be a way to evaluate the progress and public benefits deriving from the major automotive/energy company technology validation partnerships.
- Very relevant project performing a critical function.
- This project is relevant to the Hydrogen Fuel Initiative as a tool for summarizing where the technology is now.

Question 2: Approach to performing the research and development

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

- Excellent approach to maximize useful information from a massive amount of data.
- Intensive negotiations by National Renewable Energy Laboratory with industry performers and DOE have resulted in a superb system for collection, storage, securing, analyzing, and reporting on sensitive performance and other data submitted by industry.
- The approach includes providing analytical results for public use, as well as proprietary results for use by the companies providing raw data.
- The approach is dynamic, in that there are constant additions and improvements to the data collected, the systems for handling data, and the analyses provided.
- Presentation of 350 vs. 700 psi data in terms of percentages is somewhat misleading; absolute weight/volume data would be more revealing.
- Degradation analysis is an important part of the presented package; identification of clear cause(s) degradation would be welcome.
- High voltage = low current (redundancy in Slide 26).

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

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

- Significant progress in assessing data from initial fuel cell vehicle operating experience.
- Impressive success in obtaining OEM data, both vehicle and fuel cell manufacturers, and treating it in a confidential way while still identifying important operating experience and trends.
- Major accomplishments and milestones since the project's inception in FY 2003 were communicated succinctly in an outstanding single slide.
- Mr. Wipke's presentation, backed up by additional well-constructed and informative slides, provided detailed accomplishments, such as data analyzed to date and NREL's Fleet Analysis Toolkit.
- Public results have been widely and proactively disseminated through numerous conferences, reports and publications. NREL's web site allows access to 47 Composite Data Products, plus reports and presentations.
- Many examples of information communicated, and associated initiatives, were included in the presentation.
- Accomplishments are good and in line with expectations.
- This project represents a comprehensive and needed summary of hydrogen fuel cell vehicle testing.
- Useful information on safety

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

This project was rated **4.0** for technology transfer and collaboration.

- Outstanding collaborative interactions.
- Mr. Wipke and the NREL team have earned the complete confidence of industry during the course of this project.
- Close collaboration with industry partners providing data is a primary contributor to project success. Site visits with industry on methodology and sharing of perspectives is commonplace.
- Working relationships and routine interactions have also been established with many other organizations having a stake in hydrogen and fuel cell progress. These include state agencies, analytical groups, and technical teams.
- Outstanding. Providing the necessary capability for companies.
- Project is collaborative in its nature as it relies on collaboration with OEMs.

Question 5: Approach to and relevance of proposed future research

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

- Good future plans for keeping the analysis up-to-date and current.
- Plans for future work and initiatives were well summarized and clearly presented.
- Future plans are appropriate and adequately laid out.
- Future work should focus on identifying technical barriers limiting performance and efficiency of fuel cell technology for automotive transportation.

Strengths and weaknesses

Strengths
- Strong analysis methodology and comprehensive input data.
- Mr. Wipke leads a strong, experienced, flexible team, which is committed to achievement of challenging project and hydrogen program objectives.
- The NREL team has gained the highest credibility with both industry and DOE.
- Collation of data from multiple teams.
- Project provides a good summary of factors of significant potential impact on fuel cell commercialization.
- Project offers a worthwhile compilation of "real-life" data.

Weaknesses

- Technical details are not immediately available. Can the participants provide more detail after a certain time interval?
- By its nature, this project does not offer solutions to existing challenges to fuel cell technology.
- Insufficient modeling/forecasting component in the project.

Specific recommendations and additions or deletions to the work scope

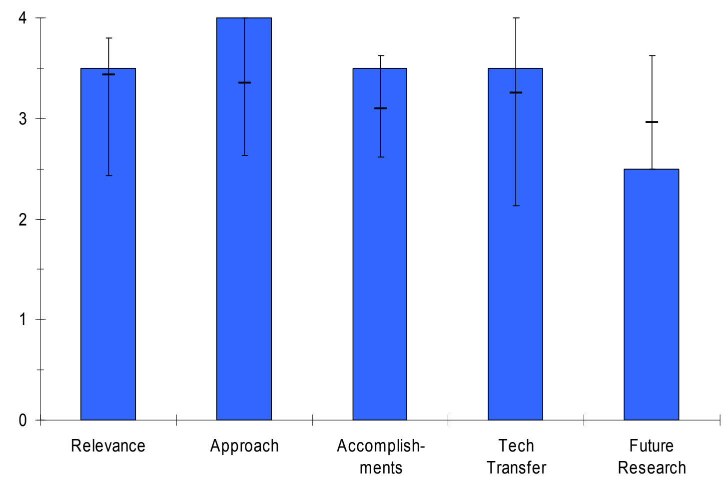
- Overall, this project represents a good summary of the state of hydrogen technology when applied to automotive transportation and should be continued.
- Forecasting should be added as an integral part of the project in the future.

Project # TV-06: Validation of an Integrated Hydrogen Energy Station
Ed Heydorn; Air Products

Brief Summary of Project

The overall objective of this project is to determine the economic and technical viability of a hydrogen energy station designed to co-produce power and hydrogen. Objectives are to 1) evaluate the feasibility of proton exchange membrane and high temperature fuel cell; 2) complete the preliminary system design; 3) complete detailed design and construction; and 4) operate station, perform testing and collect data.

Overall Project Score: 3.5 (2 Reviews Received)



Question 1: Relevance to overall DOE objectives

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

- Based on the presentation and the expertise of the company, Air Products appears capable of performing this work so that the act of producing hydrogen and power can be improved.
- This project is critical to supporting the President's Hydrogen Fuel Initiative.
- The concept of an integrated electricity and hydrogen production facility is an innovative concept and promises to encourage the use of hydrogen fueling stations even when the vehicle usage might be low, at the start of deployment.
- Although an integrated co-production electricity/hydrogen system is not necessary for the deployment of hydrogen vehicles, it does support both high efficiency electricity generation and hydrogen vehicles.

Question 2: Approach to performing the research and development

This project was rated **4.0** on its approach.

- The project presentation was well-focused on addressing technical barriers, both the problems overcome and the work remaining.
- The Air Products presentation provided an ample amount of data that clearly demonstrated and justified the scope of the company's work.
- Seems to be an excellent approach to achieving the Program goals, including high efficiency and low cost of hydrogen.

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

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

- Air Products demonstrated and presented a great deal of technical progress to meet hydrogen development goals.
- Construction is in progress.

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

This project was rated **3.5** for technology transfer and collaboration.

- Air Products made it clear that they coordinate closely with their Fuel Cell Energy colleagues and that the project depends on their teamwork.
- Good effort to proceed with permitting leveraged upon previous good experience with similar fuel cell units.
- Partnership is strong, but limited.

Question 5: Approach to and relevance of proposed future research

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

- The project appears to be winding down and that there appears to be some lack of clarity for end of project completion.
- Plans for future work are somewhat limited.
- What is next, beyond validation?

Strengths and weaknesses

Strengths
- The research enjoys a great deal of metrics that clearly marks the team's progress.
- The project appears to benefit greatly from Air Products teamwork with fuel cell energy.
- Excellent concept.
- Strong partnership, experts in their fields.

Weaknesses
- If there was/is a well-defined plan for continuation or termination, further research and development or commercialization, it was not as clear as it could have been.
- Hardware and technology usage beyond the validation are not well addressed.
- What is next?

Specific recommendations and additions or deletions to the work scope

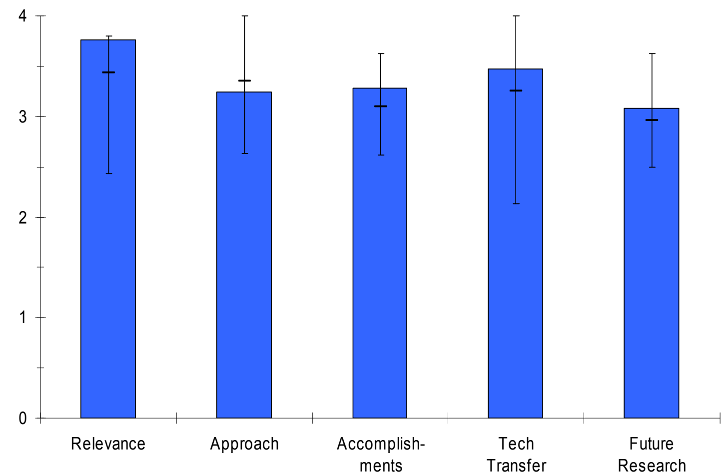
- A weakness of the project could be that they discussion did not discuss "What's next?" The presentation would have been closer to perfect if future options had been discussed.
- A power purchase agreement, with some sort of follow-on for the hydrogen generation technology would strengthen the project.

Project # TV-07: California Hydrogen Infrastructure Project
Ed Heydorn; Air Products

Brief Summary of Project

The objectives of this project are to 1) demonstrate a cost effective infrastructure model in California for possible nationwide implementation by designing, constructing and operating seven hydrogen fueling stations; collecting and reporting infrastructure data; documenting permitting requirements and experiences; and validating expected performance, cost, reliability, maintenance, and environmental impacts; and 2) implement a variety of new technologies with the objective of lowering costs of delivered hydrogen including the new delivery concept and the hydrogen-based unit.

Overall Project Score: 3.4 (5 Reviews Received)



Question 1: Relevance to overall DOE objectives

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

- The ozone analysis seems less relevant than the analysis of potential customers along the hydrogen pipeline and other hydrogen fueling options.
- Very relevant to have a major hydrogen producer involved in designs and fabrication of hydrogen infrastructure projects.
- Without hydrogen fueling stations, the hydrogen fuel cell vehicles are useless.
- This is a comprehensive project focusing on complete hydrogen infrastructure in a state, which is highly relevant to Hydrogen Initiative.
- Project is highly relevant to the Hydrogen Fuel Institutive and the goals of the Multi-Year Program Plan focusing on expanding the number and variety of hydrogen refueling stations and reducing the cost of delivered hydrogen.
- This project has an interesting and relevant twist in its efforts to integrate hydrogen infrastructure with air quality modeling to understand and best maximize the urban benefits of hydrogen vehicles.

Question 2: Approach to performing the research and development

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

- Determine cost opportunities of delivered hydrogen at seven refueling stations operated in California.
- Identify interested parties to operate the stations.
- University of California, Irvine 350/700 Bar Station commercial station.
- Long Beach Mobile Fueler.
- Torrance Pipeline Hydrogen Fueling Station
- South Lake Tahoe Mobile Fueler.
- Novel Compressor system will be demonstrated in the next couple of weeks.
- Generally very good but perhaps too much emphasis placed on the use of liquid hydrogen. It is known to be energy intensive which would seem to make cost goals more elusive.
- Having both 350 Bar and 700 Bar hydrogen is a good approach.
- Mobile fueling is a good interim step for short duration or temporary demonstrations, but spending Program dollars on such short term options may not be the best use of Program funds.

- Innovative compression might provide cost or reliability improvements.
- Modeling work does not reveal any new areas of interest, but does validate existing modeling results.
- Well thought-through approach based on existing hydrogen resources.
- The project is very sharply focused on reducing the cost of the delivered hydrogen by exploring a variety of delivery mechanisms including pipeline, innovative liquid/gaseous bulk transport and storage, mobile stations, 350 and 700 bar dispensing, and technical advances with key technologies such as compressor systems.
- Hydrogen stations are appropriately focused in the highest need area—California.
- This project is coordinated with 4 vehicle OEMs supplying fuel cell and hydrogen internal combustion engine vehicles and California institutions.
- This project will document permitting requirements and experiences for hydrogen stations.
- No discussion however is provided on how to get the word out on hydrogen and to better educate the general public.

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

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

- Developed a new liquid hydrogen trailer.
- University of California, Irvine station is well used and is in a good location. There is continued interest from a broad base of customers. This is a commercial station.
- University of California, Irvine has done some excellent analysis on emissions, green house gas emissions, energy consumption and water consumption are outputs.
- Dispensing of hydrogen at University of California, Irvine station at 700 Bar is 4-5 dollars now, but it would drop if there were more than 25 kg per day.
- Very good accomplishments with mix of technologies being developed including transporter and single stage hydrogen compressor.
- Little was presented relative to permitting, installation, liability, etc. issues which seem to be major areas of concern.
- The University of California, Irvine portion of the presentation involved little useful information.
- Modeling results for fifty year scenarios may include so much climate and technology uncertainty that their results are of questionable use.
- Only one permanent fueling station has been put into service.
- Progress on the second permanent station has lagged behind the original schedule.
- Interesting and useful air quality analysis contributed by University of California, Irvine.
- Delays in hydrogen fuel cell stations represent some setback for this project.
- Excellent technical progress with the development of the New Delivery Concept (NDC), Hydrogen Based Unit (HBU), and novel compressor system.
- This project is aggressively exploring a variety of hydrogen station and delivery options.
- No actual data has been provided with regards to costs for any of the options so not able to ascertain economic feasibility. It would be expected that by this point in the project (which ends Sept 2008), operational and cost data would be available for the earliest options explored (University of California, Irvine 350/700 bar station and HF-150 mobile refuelers at least).

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

This project was rated **3.5** for technology transfer and collaboration.

- University of California, Irvine has helped analyze the infrastructure deployment in S. California.
- They developed a model from a lifecycle perspective. This model was used to analyze the distributed and centralized hydrogen generation.
- They also developed a model to analyze air quality impacts of Fuel Cell vehicle penetrations through the year 2060.
- There appears too is excellent collaboration with University of California, Irvine and various governmental groups.

- A partnership with a university, as has been done with University of California, Irvine, is an excellent approach.
- A partnership with a vehicle manufacturer, or additional partnerships with automotive manufacturers, might help to provide better station utilization for the long term.
- Role of collaborators not clearly defined, except for that of the University of California, Irvine.
- Project appears to have a diverse set of partners including California institutions and vehicle OEMs.
- Little discussion, however, is provided as to formal technology transfer and collaboration amongst partners. It is not clear what each partner is doing, intellectual property arrangements, etc. On the surface, the "partnerships" appear not so much for the purpose of neither technology transfer nor collaboration but to gain access to certain sites or specific information.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.1** for proposed future work.

- Why develop the liquid hydrogen dispensing system?
- First pipeline station.
- Very good.
- Important that pipeline project is implemented.
- Proposed work should include studies to determine tradeoffs of costs between the uses of liquid hydrogen versus additional delivery trips of gaseous hydrogen.
- Continuing to provide demonstrations of mobile vehicle fueling does not support a permanent long-term hydrogen infrastructure and may not be the best use of program funds.
- Very sound list of proposed research task for the remainder of the project.
- The project is looking at a broad set of hydrogen refueling options and technologies, but has not adequately discussed the future for carrying on the stations once the project ends in September 08.
- Little discussion is provided on means to increase utilization of the hydrogen stations now and in the future either through additional hydrogen vehicles (such as buses) or other innovative means.
- No discussion is provided with regards to means for downselection of various hydrogen refueling options.

Strengths and weaknesses

Strengths
- Using existing infrastructure such as the pipeline and trying to make sense of the cost and availability of customers.
- Technical capabilities, interactions with other groups.
- Partnership with University of California, Irvine.
- Air Products expertise in hydrogen.
- Combined liquid and gaseous hydrogen delivery.
- Overall, a strong and relevant project looking at a variety of hydrogen options with a strong emphasis on reducing cost.
- Solid technical progress in several areas.
- Seemingly broad and relevant team is assembled.

Weaknesses
- None.
- Possibly too much emphasis on liquid hydrogen.
- Little information relative to cost issues. Either not being done or done and not presented.
- Modeling studies of fifty-year scenarios may not be the best use of program funding.
- Schedule delays on the second permanent station.
- Only one permanent station has been installed and operated.
- Little if any discussion of actual mechanisms for technology transfer and collaboration amongst partners.
- Little discussion provided on means to continue existence of the stations at the end of the project and ways to increase hydrogen utilization.

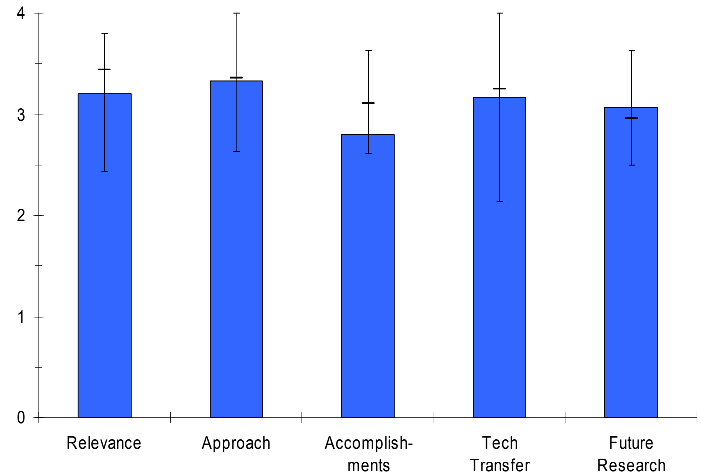
Specific recommendations and additions or deletions to the work scope

- None.
- Recommend more emphasis on cost issues.
- A better approach to the intent and results of the University of California, Irvine work would be useful.
- Additional permanent stations, in partnership with vehicle manufacturers, may strengthen the project.
- Funding for mobile hydrogen fueling stations might be redirected to permanent fueling stations to enhance the effect on the permanent hydrogen infrastructure.
- As this project is expected to end soon, there is no need for any modifications between now and the end-date.
- One-year extension could be of value to the DOE Program.
- Hydrogen cost analysis is needed.
- Put into place concrete plans for institutionalizing the hydrogen stations by assembling entities that would continue to use the facilities after the project ends.
- Establish means to increase awareness and acceptance of the hydrogen stations by the general public.

Project # TV-08: Hawaii Hydrogen Center for Development and Deployment of Distributed Energy Systems
Richard Rocheleau; Hawaii Natural Energy Inst.

Brief Summary of Project

Overall Project Score: 3.1 (3 Reviews Received)



The objectives of this project are to 1) develop, validate and collect performance and cost data on the Hawaii Hydrogen Power Park, an integrated hydrogen system (electrolyzer, hydrogen storage, and fuel cell); 2) evaluate renewable hydrogen production from biomass including evaluating the H_2 yield potential of Pearson Technologies' gasification process and characterizing technologies for tar reforming and H_2 purification; and; 3) develop a strategic energy roadmap to identify economically viable technologies to transform the Big Island energy infrastructure including baseline models for electricity and transportation and identifying scenarios to facilitate acceptance of emerging new energy systems including hydrogen.

Question 1: Relevance to overall DOE objectives

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

- The project presentation clearly demonstrates and greatly supports the President's Hydrogen Fuel Initiative.
- The project demonstrates on a micro level the complexities of using a variety of energy sources to provide grid/microgrid power.
- This project comprises four tasks. Each has some potential relevance in generating movement toward greater energy diversity and independence for Hawaii.
- Funding was provided in FY 04 and FY 05, and most work is completed. The results have provided some value in laying the foundation for activities that could have particular future energy benefits for Hawaii.
- The project is expected to have little or no benefit in terms of contributing to achievement of Department of Energy's Hydrogen goals, targets, and objectives.

Question 2: Approach to performing the research and development

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

- Approach is broad based. Appears to be larger than one person can over see when collaborations taken into account.
- Approach for use of biomass is weak and could easily be strengthen to be the center point of this project.
- The Hawaii Natural Energy Institute team addressed not only programmatic challenges but the technical challenges of developing and measuring a grid from multiple energy sources.
- The team demonstrated a great ability to integrate their work with other alternative energy research.
- The hydrogen power park task linked existing renewable infrastructure, a test bed for fuel cell technology, and analytical support by modelers at Sandia National Laboratory. The linkages and collaborations in this task resulted from a sound concept.
- Performing energy road mapping for the Big Island also seems like a good idea. It should have been implemented as part of an overall integrated plan for Hawaii's energy future, with the results of the integrated plan being used to determine project goals, priorities, and activities. It seems this was not how tasks were selected for funding.

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

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

- Amount of information generated by this project is minimal for the funding received. There is not long-term data collection or dissemination.
- Biomass clean up with ZnO is not new, this data is right out of literature. There are numerous better choices for sulfur remediation— consider rescoping this part of the project.
- The HNEI project team presented a great deal of data to demonstrate and measure the project's progress.
- To meet hydrogen and energy goals for the nation, many efforts such as this will be required to learn management requirements to integrate and wisely use alternative and renewable energy technologies.
- Completed and nearly completed tasks are resulting in incremental knowledge and experience for those who worked on them and relatively few others.
- It is doubtful that this project has contributed to meaningful progress toward a transition to hydrogen, or to achievement of DOE Hydrogen Program goals/objectives.
- Technical work on the hydrogen power park (task 1) and renewable hydrogen production from biomass (task 3) could assist in advancing technology. The results of this work should be communicated to those with appropriate expertise and an interest in related technologies.
- Outreach associated with task 1 is a good initiative.

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

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

- Collaborations are extensive, but how are they distinguished by task? Most appear to support power park work.
- The project clearly demonstrates a strong collaborative effort with a wide variety of public and private organizations.
- A number of cost share partners were identified in the slide presentation. Some collaboration was also identified in slides on project approach and accomplishments.
- There was little discussion or mention of collaboration and coordination with others during the oral presentation.
- There are working relationships established with officials, organizations, and communities in Hawaii.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.1** for proposed future work.

- More elaboration on future R&D is warranted on tasks to be funded by DOE.
- The relevance of this project by HNEI is clearly applicable to meeting the nation's energy's requirements and managing a variety of energy sources to reliably meet community requirements.
- The presentation included recommendations for future hydrogen power park work, including Kahua Ranch education and outreach, and installation of a hydrogen fueling infrastructure at Hawaii Volcanoes National Park.
- Work on other tasks is evidently continuing under separate agreements.

Strengths and weaknesses

Strengths
- The presenter did a good job of conveying the difficulties of putting an alternative energy/hydrogen project together.
- Work on the tasks in this project should increase the visibility of hydrogen—and its potential—within Hawaii.

Weaknesses

- Amount of information generated by this project is minimal for the funding received. There is not long-term data collection or dissemination.
- The work is not linked well with DOE's Hydrogen goals and objectives.
- It is not evident that a sufficiently developed, rigorous plan exists for guiding the project activities.

Specific recommendations and additions or deletions to the work scope

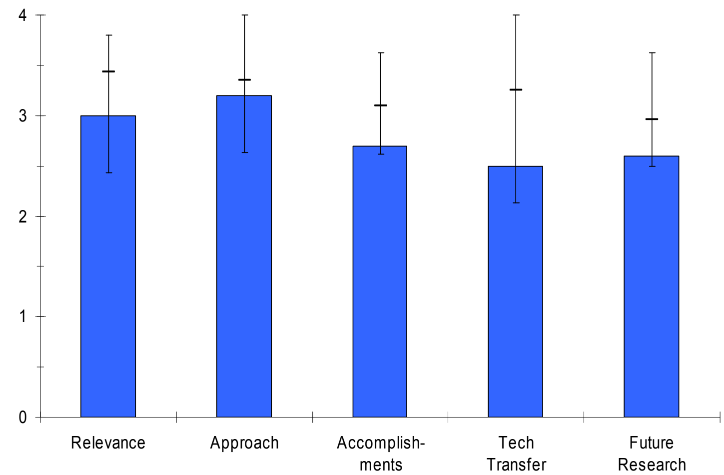
- Put into place concrete plans for institutionalizing the hydrogen stations by assembling entities that would continue to use the facilities after the project ends.

Project # TV-09: Cryogenic Capable Pressure Vessels for Vehicular Hydrogen Storage
Salvador Aceves; LLNL

Brief Summary of Project

The overall objective of the program is to demonstrate the practical advantages of cryogenic capable pressure vessels for hydrogen vehicles, including high energy density, no evaporative losses, flexible refueling and safety. The project has installed a pressure vessel in an experimental vehicle, and demonstrated long vehicle range (650 miles on a single tank), vacuum stability, and resolved technical risk of dormancy and high pressure.

Overall Project Score: 2.8 (5 Reviews Received)



Question 1: Relevance to overall DOE objectives

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

- This is a long-term project to develop cryo-tank development for hydrogen storage.
- Somewhat similar, liquid hydrogen storage is already in prototype vehicles (BMW).
- Interesting alternative storage system, since it opens up perspectives to reach specific volume and weight targets
- For automotive application it will not only be important to meet the specific technical targets (kg or liter per kWh), but the overall system needs to meet the packaging needs of the OEMs. As could be seen from the Prius pictures the 10 kg hydrogen storage is (although the specific values are not bad) not suitable for a compact to mid-sized vehicle. Cryo-compressed hydrogen storage shows an interesting perspective wherever larger amounts (>5 kg) need to be stored on-board. In terms of relevance for the program, the market perspective needs to be taken into account, since the fuel cell vehicles being developed by the OEMs usually range in the mid-size segment. This is also of relevance for the cost analysis, which is based on volumes of 500,000 units per year. This seems to be an unrealistically high volume assuming that most OEMs will start commercialization with high-pressure gaseous storage.
- The aspect of fuelling flexibility needs to be assessed further. In principle it is true, that these storage systems can be refueled either at a regular 5,000 psi gaseous station or at stations that offer liquid hydrogen. Whereas the regular 5,000 psi fueling does not offer advantages to the customer (why should he pay for the extra cryo-equipment?) the cryo-fill requires extra measures at the fueling station (which adds costs) and might require the combination with regular gaseous refueling to avoid wasting/blowing off hydrogen. This is relevant to the overall program since infrastructure build-up is one of the most critical issues which require cost effective concepts.
- Although boil-off does not occur since the hydrogen at low temperature and high pressure is in a supercritical phase, venting cannot be avoided once the maximum pressure is reached (dormancy time depending on customer driving habit). Hence the cryo-compressed hydrogen storage system is an open system which requires specific safety concepts on-board the vehicle. This has relevance to the overall Program in terms of safety concepts and RCS.
- In good alignment with 2010 goals but not 2015 as they stand.
- However, probably the best overall system available at present and potential to replace normal compressed gas.
- The project focuses on one of the Department of Energy's key objectives which is to improve on-board hydrogen storage options available to the OEMs.
- This project has achieved 10 kg of hydrogen storage on a vehicle in a reasonable sized tank. This goal of high density hydrogen storage on vehicles, in a safe manner, is extremely relevant to DOE's Hydrogen Program.

- Excellent demonstration of potential affordability of this approach (slide 13) comparing this tank's costs to other hydrogen storage methods. Cryo-compressed could be more economical than other methods such as compressed hydrogen at moderate (5000psi) and high (10,000psi) pressures.
- Showing where cryo-compressed is now and where it needs to go, emphasizes the relevance of the research (slide 16). System capacity by volume and weight are important to continue to improve with this research.

Question 2: Approach to performing the research and development

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

- Storage hybridization is a powerful way of resolving intermediate needs and this approach addresses that.
- However in the long run the approach has significant barriers which are beyond the scopes of this program to address.
- The main critical technical issues are dormancy time and vacuum stability which are addressed in the project.
- Cycling behavior as another critical factor is planned.
- Overall, it was unclear as to how specific automotive requirements are taken into account. This needs to be assessed further (mechanical and thermal stress).
- Generally good though not always clear what the integrated plan is.
- Not clear that liquid nitrogen fill makes sense in that the cooling of the tank will be expensive or slow.
- The technical approach to finding a unique hydrogen storage solution is excellent.
- The balance of both theoretical and experimental is perfect and a model for other projects to follow.
- This project is capitalizing on LLNL's extensive experience working with hydrogen over the past 40 years and related specialized equipment (such as high temperature/pressure ovens (slides 11 and 12), and high pressure containment rooms). This project is applying these valuable resources developed originally for other purpose for the hydrogen vehicle program.

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

This project was rated **2.7** based on accomplishments.

- Progress in this project seems to have slowed significantly.
- Incomplete results in dormancy test and insulation outgassing tests.
- Dormancy time: Only one experiment was presented to assess the dormancy time. The predicted 3 weeks dormancy time is based on a weak experimental database as well as on the assumption that the lowest measured heat transfer can be maintained over a longer period of time. This needs to be assessed further. Mechanical and/or thermal stress arising from automotive use needs to be taken into account.
- The cost analysis compares 10.7 kg hydrogen in the case of cryo-storage with 5.6 kg in the case of high-pressure storage. The respective specific values are not directly comparable. Either both concepts address different vehicle types (in this case a direct cost comparison is misleading) or the two concepts compete in the range of 5-7 kg hydrogen storage. In the latter case a cost comparison needs to be based on the same amount of hydrogen stored.
- Important milestones in demonstrating vacuum stability and dormancy.
- Cost numbers look good.
- Only counting progress since 2007 Annual Merit Review, other progress earlier.
- Significant progress has been made in the last year, and experimental results are excellent.
- The Addition of both an OEM and a tank supplier will take this to the next level of maturity. Congratulations on securing these two partners.
- Demonstrated six days of dormancy (slides 4, 7, 8) and potential for three weeks of dormancy; plotted data(slides 7 and 8) is excellent; greater explanation needed for increase in temp and pressure at 135 hours — mentioned in talk not in slides (slides 7, 8).
- Demonstrated vacuum stability under warming (slides 4, 13).
- Outgasing and cycle tests.
- Plotted data on heat transfer into vessels is excellent.
- Demonstrated practicality of cyro-compressed hydrogen (slides 4 and 8) in a hybrid vehicle.
- Previously demonstrated long vehicle range (slide 4).

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

This project was rated **2.5** for technology transfer and collaboration.

- It appears to have limited interest from USCAR partners. USCAR partners have been engaged through several cyro-compressed workshops.
- No apparent partners or collaborations for this projects - although it was reported that some are in the negotiation stage. But it is not clear why there has been no interactions in the over three years that this project has been underway.
- Close collaboration with an OEM was mentioned, which is absolutely necessary to assure automotive feasibility
- Since the cryo-compressed storage concept has major impact on the infrastructure (especially on station design) it is highly recommended to start detailed discussions with energy companies.
- Questions regarding material behavior at low temperatures and high pressures should be addressed within the collaboration mentioned with a vessel manufacturer.
- A relationship with BMW would be appropriate as they are doing similar work.
- I look forward next year to hearing more about the benefits of the collaboration with your new industry partners.
- This project has spun-off its work to a major automotive company, which is trying to integrate this type of tank in their hydrogen cars.
- Finalizing CRADA with major auto manufacturer (slide 2).
- Negotiating CRADA with major pressure vessel manufacture (slide 2).
- The design and manufacture a new cryogenic pressure vessel for full cycle testing (slide 15) is very important to do with industrial partners.

Question 5: Approach to and relevance of proposed future research

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

- Plan for future work is vague and not clearly stated.
- Building a next generation storage system and testing it under real-world conditions is the right approach. This requires a close collaboration with an OEM.
- More focus should be put on extensive testing under automotive conditions as well as the impact on infrastructure (including customer acceptance, i.e. will customers accept, that they get different filling-levels depending on the station they go to).
- Materials behavior at low temperatures and high pressures needs to be addressed.
- Direction is excellent.
- Details are hazy.
- More details could be provided about future work, such as how the next generation system build will improve upon your current generation
- What will change in the next generation system that will allow you to meet the 2010 goals?
- Demonstrating future cryo-compressed system capacity by weight and volume would be extremely helpful, especially if performance exceeds liquid hydrogen tank expectations.
- Design and manufacture a new cryogenic pressure vessel for full cycle testing (slide 15) is excellent to do with industrial partners, to better address the temperature and pressure profile of the tank during warm up and refueling. This kind of collaboration (between refueling station and tank developer) is necessary for success of the entire refueling system.

Strengths and weaknesses

Strengths

- The strength of this project is the combination of two well-established technologies for hydrogen storage.
- It builds on the positive aspects of each physical storage technique.
- Engineering developments.
- Interesting alternative storage concept for larger hydrogen quantities.
- Interaction with OEM and vessel manufacturer.
- Good concept, team has expertise in area and is responsive to input.

- Higher density of hydrogen allows for smaller tank and thus cheaper than compressed hydrogen.
- Good balance of theory, experiment, and demonstration.
- Successful linkage for the future with industry partners.
- Valuable technical achievement toward DOE technical targets for storage.
- Demonstrated high range and vacuum stability.
- Excellent teaming with industry and spin-off of technology.
- The integrity of the research team is high, as well as their enthusiasm for this work and technical experience in this area. Very few research groups around the world could assemble this combination of excellent thinking and experience in hydrogen storage.
- This project is a hallmark example of "turning missile silos into plowshares." It is a superb example of converting the technical expertise developed for the weapons program into engineering science innovation for sustainable energy.

Weaknesses

- Page 7 shows the fundamental technical limits of this concept (excluding the infrastructure and well-to-wheels efficiency shortcomings). Contrary to the presented interpretations, the data reflects why this technology is of limited use outside controlled fleet.
- It was reported that the shortened dormancy test was due to a valve failure, but this is very important since valves will surely be balance of plant components in any eventual system. This problem must be studied and solved.
- More experiments needed (automotive requirements).
- High cost structure limits progress, use of lower cost labor where possible would be wise.
- Probably can not meet 2015 goals, but since this is the leading new method of storage, do not emphasize that weakness.
- Tank more expensive than liquid hydrogen of same capacity.
- Lay out more detailed plans for future work.
- Describe improvements planned for next generation build.
- Speaker and presentation should clearly delineate previous years accomplishments compared with this year's accomplishments. For example, tank integration occurred in previous fiscal year (Jan 2007). Project could emphasize more strongly increasing system capacity by volume and weight. Project would benefit from some DFMA (Design for Manufacturing Analysis) taken into account in any tank re-designs. Please include a team member with DFMA experience during the tank re-design process that is being done in conjunction with industry.

Specific recommendations and additions or deletions to the work scope

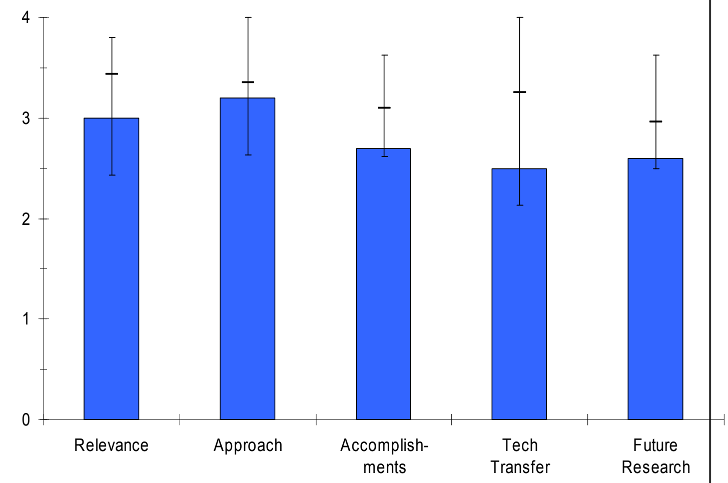
- Since this projects starts from a higher level of established development (prior art), it is reasonable to expect the team to address:
    - Storage module cost (as compared to either cryo or compressed system).
    - Infrastructure requirements.
    - Overall well-to-wheels energy efficiency.
    - Shortcomings in volumetric storage and finally a definite solution for over-pressurization/venting problem.
- It is recommended that this project be shortened and brought to timely conclusion.
- Objective: Demonstrate the practical advantages of cryogenic capable pressure vessels; 'practical' should be specified in more detail: automotive conditions and impact on infrastructure.
- Develop a clearer and more structured plan to reach 2010 goals and have DOE vet it.
- Work toward a more realistic packaging for your next vehicle demonstration (should not take up the whole trunk of a vehicle).
- Despite industry partner involvement for future and Cooperative Research and Development Agreement limitations, ensure that adequate technical results continue to flow out from this project.
- 1) DOE should fund further cryo-compressed tank prototypes, with updated designs and newer materials.
- 2) DOE would benefit by allowing the LLNL researchers who have developed this technology to take wider credit for this work. For example, peer-reviewed press releases from LLNL on their research should be encouraged. The DOE's image in the public eye can be enhanced by allowing its researchers to take credit for their work, so long as they emphasize the infancy of the technology and additional R&D contributions needed.

Project # TVP-01: Florida Hydrogen Initiative
Pam Portwood; Florida Hydrogen Initiative

Brief Summary of Project

The Florida Hydrogen Initiative is a non-profit organization incorporated under the laws of the State of Florida to move Florida to the forefront of the nation's hydrogen economy. The Florida Hydrogen Initiative has funded four projects to date 1) the HyTech Rest Area project to demonstrate the use of hydrogen derived from citrus waste in a fuel cell located at a Florida Turnpike rest area; 2) the development of location strategies for the initial hydrogen refueling infrastructure in Florida that would be required to support consumer demand and a hydrogen powered car rental fleet for Orlando, Florida; 3) designing and building a museum exhibit to tour 18 Florida science museums to inform and educate the public about hydrogen's potential and use as an energy carrying medium and the future role of hydrogen in energy distribution; and 4) the on-site reformation of diesel fuel for hydrogen fueling station application.

Overall Project Score: 2.8 (5 Reviews Received)



Question 1: Relevance to overall DOE objectives

This project earned a score of **2.4** for its relevance to DOE objectives.

- The four topics are excellent and will help the Department of Energy achieve its goals and objectives.
- This project is a set of relatively small sub-projects, which result from funding of proposals made to the Florida Hydrogen Initiative.
- At least two of the four projects discussed are expected to have little or no benefit in terms of contributing to achievement of DOE's Hydrogen goals, targets and objectives.
- Most of these projects seemed to address issues that are not core to the Program's mission
- This project consists of 4 discrete activities: 1)HyTech Rest Area, 2) Hydrogen Refueling Infrastructure and Rental Car Strategies, 3) Public understanding of hydrogen, and 4) On site reformation of diesel. Activities 2 and 3 are complete.
- 1) HyTech project shows solid relevance to Hydrogen Fuel Initiative goals including the use of local and renewable resources to generate power.
- 2) Rental car strategies project is relevant as a means to increase exposure to hydrogen vehicles and accelerate adoption. Given the cost of hydrogen stations it is imperative to maximize the use and location of each station. This project lends itself to credible strategies for doing this.
- 3) Public understanding of hydrogen project is a small but viable element to increasing public awareness and acceptance of hydrogen. Clearly dovetails into other education components.
- 4) It is highly unlikely that diesel fuel to hydrogen conversion will ever be viable economically or from an efficiency standpoint with other hydrogen distributed fuel pathways.
- Multiple projects, with multiple effects, all in Florida could improve the public perception climate for hydrogen, especially in Florida, while developing diesel reforming.
- Educational highway display.
- Citrus derived hydrogen.
- Hydrogen refueling location studies.
- Educational museum display.
- Diesel reforming.

- This project has some relevance to overall DOE objectives.
- The project has 5 different, disconnected projects that do not appear to be at all integrated.

Question 2: Approach to performing the research and development

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

- On-site reformer attempts to lower H_2S to < 50ppm were not successful.
- The sub-projects selected for funding are each relatively small, independent activities. It would be preferable for each project to be funded in the context of an overall Florida Hydrogen Initiative plan that is linked to DOE's Hydrogen Program goals and objectives.
- Consideration should be given to using more project funds for hydrogen education initiatives in Florida.
- Most of the project approaches appear to be reasonable.
- HyTech approach is reasonable and methodical.
- Rental car strategies project approach is sound lending itself to optimal placement and utilization of each hydrogen station. However, it is questionable whether the general public will actually rent hydrogen vehicles ad hoc at this time due to perceptions with respect to safety etc. It is highly unlikely that a family coming to Disney World will rent a hydrogen vehicle. As mentioned later in the poster session, more likely early experimenters are techies, professors, etc. in university towns or at clusters of technical companies.
- Public understanding project approach is solid emphasizing hands on activities and touring expedition to increase exposure.
- The approach for the onsite diesel reformation project is not will detailed and is difficult to assess.
- Each separate task appears to be well managed and moving along well.
- Coordination between the project tasks is not addressed.
- The overall approach was not clearly presented.
- With 5 discrete projects, there was no recognizable cohesive.
- A few projects discussed approach, but not all.

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

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

- Were the HyTech Oct '07 and Jun '08 milestones accomplished?
- Completed sub-projects are resulting in incremental knowledge and experience for those working on them and a relatively few others.
- It is doubtful that meaningful progress toward a transition to hydrogen is enhanced by this work.
- The sub-project on reformation/de-sulfurization of diesel fuel could advance technology, but funding should be provided more logically from sources other than the Hydrogen Program.
- HyTech: Not clear if >32% efficiency will even be achieved, but it seems likely that other technology options would be more efficient and reliable.
- Hydrogen Refueling: Interesting model results and good use of existing information from the National Renewable Energy Laboratory model.
- On-site Reforming: Not clear how much funding was spent on this project.
- Technical accomplishments and progress are on schedule for HyTech although significant detail is not provided. Project appears to be schedule for completion in the Fall of 2008.
- Rental car strategies project is complete and appears to achieve its objectives.
- Public understanding project is complete and appears to have met objectives.
- Solid technical progress and accomplishments appear to have been achieved for the diesel reformation project.
- All project tasks are making good progress.
- With the exception of the on-site reformation of diesel fuel for hydrogen station fueling applications" project, technical accomplishments were weak. Seems like more should be accomplished by now (2 years into the project).

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

This project was rated **2.1** for technology transfer and collaboration.

- These projects make good use of academic organizations and demonstrate a high level of collaboration with industry.
- There has been some interaction with other modelers on the refueling infrastructure project that has been completed.
- In general, it seems that sub-project plans and results are not being sufficiently shared with those interested in the results.
- Work on the diesel reformation project should be discussed with DOE's Fossil Energy staff.
- Overall, these projects would benefit from working with more partners outside of the Florida hydrogen Initiative
- HyTech project has relatively broad connections with other entities (such as citrus ethanol producers), with the exception of drawing upon the experience of past stationary, biomass derived fuel cell power stations applications.
- Rental car strategies project collaborated well with other university researchers in Florida, but has no evident collaboration with others. This project would benefit from expanding it universe to other entities such as energy companies and Kennedy Space Center which has excess hydrogen capacity.
- Public understanding project has established and leveraged collaborations with important other entities including Disney, and US Department of Education.
- Only collaboration identified for diesel reformation project is Chevron. Project would benefit from other industrial entities experienced with stationary hydrogen fuel cell siting and application.
- Additional coordination between the project tasks might be helpful.
- Technology transfer and collaborations not directly addressed.

Question 5: Approach to and relevance of proposed future research

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

- These projects (all 4) should be fully funded to complete the work
- Future sub-projects will be selected from proposals submitted to the Florida Hydrogen Initiative.
- Potential future work was not identified in response to questions, though more funding for the project will evidently be available.
- Proposed future projects for HyTech is reasonable if underdeveloped. As the project is nearing completion, extensive effort should be made to determine explicit economic targets necessary to commercialization viability and utilize knowledge learned to examine other possible biomass derived fuel cell power plant options.
- Proposed future research for rental cars strategies project is excellent especially as results could be equally applied to any alternative fuel. A good idea would be to work outside the university boundaries and look to coordinate a nexus using this tool with deployers of alternative fuels and other states.
- Public understanding project should consider being toured nationally as well.
- Proposed future research is reasonable for diesel reformation project.
- Projects continue toward realization of goals. The next year will be critical.
- Only the diesel reformer had much discussion of future work.

Strengths and weaknesses

Strengths
- Good use of funding for four distinct projects .
- Work on some sub-projects should increase the visibility of hydrogen—and its potential—within Florida.
- Some good work, but overall grouping of projects does not seem to fit with any one core objective.
- HyTech project is relevant for fuel diversification and utilization of local resources.
- Rental car strategies project provides good insight into hydrogen station deployment strategies to maximize utilization and cost effectiveness.

- Public understanding project is a solid awareness and outreach effort for hydrogen.
- Good goals and approaches.
- Some of projects will have some good outreach value based on their high visibility (rest area project).

Weaknesses
- The onsite reformer tested did not allow H_2S scrubbing down to 50 ppm but the summary states the best metal to chelate system was capable of reducing H_2S to <50 ppm. This is confusing. Only one statement can be true.
- The work is not linked well with DOE's goals and objectives.
- An overall plan for guiding the project activities is not sufficiently developed or rigorous.
- Too focused on one state.
- HyTech project would benefit from collaboration with other firms which have conducted similar biomass or renewable energy based fuel cell stationary applications.
- Rental car strategies project may benefit from reconsideration of strategy to utilize rental cars as initial "market" for hydrogen vehicles. Perception issues may make this a hard sell.
- Diesel reformation project ostensibly has no relevance to the other projects of the Florida Hydrogen Initiative and is surely not locally native to the state.
- Focus on Florida might be improved with additional coordination between the project tasks and additional coordination with other states and locales.
- There is no common thread among the projects, except that they are all in Florida. The projects really need to be reviewed individually as 5 separate projects
- Need to make more technical progress than has been demonstrated to date.
- At the poster, the presenter was a contracts administrator, not a technical person, so most of the information for this review had to be obtained from the PDF file.

Specific recommendations and additions or deletions to the work scope

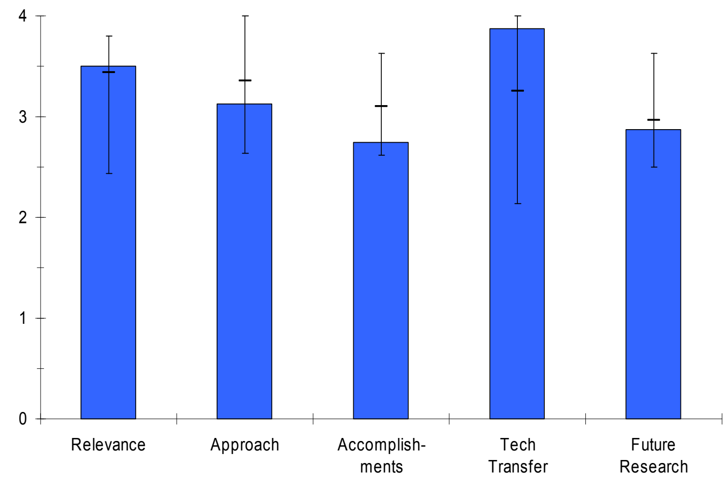
- Get NEPA permit for HyTech (as soon as possible).
- Terminate diesel reformation project as diesel to hydrogen reformation is highly unattractive from an efficiency and cost standpoint. Additionally, it does not fit within the context of the Florida Hydrogen Initiative.
- More integration between the project tasks
- More integration and coordination with other regions, states and the national programs.
- Given the overall weakness of the project as a cohesive package, the recommendation would be to separately review these projects (perhaps as posters) in the future so that reviews/feedback can be more direct and useful to the PIs.
- The station location analysis project probably has the most relevance to DOE's goals, so this project should be expanded.

Project # TVP-02: Technology Validation: Fuel Cell Bus Evaluations
Leslie Eudy; NREL

Brief Summary of Project

The overall objectives of the project are to 1) validate fuel cell and hydrogen technologies in transit applications; show progress of the technology toward commercialization; 2) provide "lessons learned" on implementing next generation fuel cell systems in transit operations; and 3) harmonize data collection efforts with other fuel cell bus demonstrations worldwide (in coordination with FTA and other U.S. and international partners). Objectives for 2008 are to 1) complete updated reports on AC Transit and SunLine; 2) begin data collection and analysis for first cold climate site, **CT**TRANSIT; and 3) provide a summary of the fuel cell bus experience and analysis of status.

Overall Project Score: 3.1 (4 Reviews Received)



Question 1: Relevance to overall DOE objectives

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

- This project is essential if the Department of Energy objectives are to be met.
- This project appears to fully support the Presidents Hydrogen Initiative.
- Fleet program is an imperative step toward commercial variability.
- Accumulated data during real usage is valuable for fuel cell research and development.
- Although DOE is focused primarily on light duty transportation and the Department of Transportation is addressing heavy duty applications, it is extremely important that everyone understand the technology status and barriers that must be addressed prior to full commercialization of fuel cell vehicles.

Question 2: Approach to performing the research and development

This project was rated **3.1** on its approach.

- The project collects data and compares to other international efforts.
- Barriers are addressed clearly.
- The approach to completing this project appears fully complete and well thought as documented in the team's presentation.
- As provided the data advises that a great deal of effort was accumulated and processed for use.
- Analysis seems to be superficial (simple data comparison). Deeper analysis, e.g. performance/failure analysis with usage profile should be more valuable.
- Excellent job of making real operational data available for all to view and use.
- Getting agreements with fuel cell manufacturers and being able to publish aggregated data is very important.

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

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

- Very clear, easy to read results. Related to DOE objectives.
- This project shows excellent progress. Results are clearly shown.

- The project did a fine job of providing a snapshot of fuel cell bus costs, but the project could have been improved by comparing a history of costs and future trends. In other words, is a historical trend available and can one determine what future costs can be?
- Fleet data were just simply compared among three fleet programs. It would be more meaningful if the data is analyzed with usage profile and vehicle specifications.
- Unfortunately, a lot of time has been expended negotiating agreements on the collection and sharing of data.

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

This project was rated **3.9** for technology transfer and collaboration.

- The transit companies participating embrace the whole community.
- From their presentation, National Renewable Energy Laboratory fully coordinated their collaboration efforts.
- Project organized and appropriate data publication.
- Progress on getting worldwide consistency in data collected and published is good.
- DOT is finally (planning on) participating with funding.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.9** for proposed future work.

- This project should be fully funded for future work.
- The project appears to focus on completing their work in an "as is" data collection service. The project team might be able to improve their product if they could project from some of the observations.
- Data mining approach would be appropriate.
- Development of database for failure information and lessons learned would be valuable.
- Continuing the data collection and publication on the National Fuel Cell Bus Demonstration is excellent.

Strengths and weaknesses

Strengths
- Good geographic diversity with various temperate real world conditions to evaluate performance and cost.
- Consistent data collection and evaluation of comparable; international efforts is highly desirable. This approach maximizes benefits and minimizes cost!
- The project is fulfilling a necessary requirement by measuring data.
- Access real world data.
- One location for all fuel cell vehicle data is extremely beneficial for everyone that has need for the data.

Weaknesses
- None.
- The project appears to focus more on accounting data, but could benefit from greater analysis.
- Data analysis methodology.
- More effort must be made to get the data publically available, especially aggregated proprietary data.

Specific recommendations and additions or deletions to the work scope

- Fleet summary for HIISNA. Determine if there are any results for HI AIRFORCE Demo?
- The database and publications should include every fuel cell bus in operation.