

**HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE
MEETING MINUTES**

November 3-4, 2011

L’Enfant Plaza Hotel, Washington, D.C.

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DAY 1 – NOVEMBER 3, 2011

1. Hydrogen and Fuel Cells Technical Advisory Committee (HTAC) Business

- **Approval of Meeting Agenda**
Agenda for the November 3-4, 2011 HTAC meeting was approved without comment.
- **Adoption of minutes from previous HTAC meeting**
The minutes of the June 14-15, 2011 HTAC meeting were adopted without comment.
- **2012 Meeting Planning**
The members agreed to the following dates for 2012 HTAC meetings.
 - February 9, 2012. 10am EST teleconference
 - May 9-10, 2012, Washington, DC. Location TBD
 - November 15-16, 2012 in Washington, DC OR November 8-9 at Mohegan Sun Casino, CT. The later coincides with the 2012 Fuel Cell Seminar. Members should hold both dates at this time.

2. Public Comment Period

Chris White, Communications Director, California Fuel cell Partnership (CaFCP)

Ms. White discussed the CaFCP's memorandum of understanding (MOU) with the Western States Petroleum Association (WSPA), the purpose of which is to create a stream of revenue for early hydrogen fueling infrastructure to forestall or change proposed regulations (e.g., the Clean Fuels Outlet Regulation) in the State of California.

Questions, answers, and discussion

- Chairman Shaw asked about the proposed timetable for a decision.
 - A decision from the California Air Resources Board is expected soon.
- Dr. Cardillo asked which gas companies are involved in the MOU.
 - Shell, Chevron, ConocoPhillips, and BP have been present at every meeting. Tesoro and ExxonMobil have been present at some meetings. Only big oil producers that belong to WSPA have been involved.
- Mr. Eggert added that the WSPA-CaFCP partnership has developed a more specific estimate of the early infrastructure needs and investment costs in California, and stated that it was quite modest – less than \$100 million. Chris White noted that the CaFCP has worked with automakers to develop an estimate of about 50,000 fuel cell vehicles being introduced in California in the 2015-2017 timeframe.

3. DOE Hydrogen and Fuel Cell Program Update

3.1 Mr. Steve Chalk, Deputy Assistant Secretary for Renewable Energy, Office of Energy Efficiency and Renewable Energy (EERE)

At the invitation of the Committee, Mr. Chalk provided brief opening comments. He noted that the DOE budget is still under Continuing Resolution. Although the budget cut and uncertainty has presented a significant challenge to the agency and the Fuel Cell Technology Program (FCTP), he stated that the FCTP has had one of the highest returns on investment within the EERE and he is pleased with the program's management and achievements. He expressed his

hope that the budget for EERE would not be further reduced in 2012. Mr. Chalk highlighted the potential for synergies between natural gas and hydrogen, particularly with regard to fueling infrastructure, and noted that the Department is beginning to look into this, as well as liquid natural gas fueling for heavy duty trucks. He noted that while DOE's main role is to invest in high-risk R&D, versus hardware like wind turbines, there may be a role for DOE in the installation of hydrogen infrastructure in order to kick-start early markets.

Questions, answers, and discussion

- Dr. Shaw asked what the impact would be if the congressional "Super Committee" could not reach consensus on a budget.
 - Mr. Chalk said that no guidance had so far been given to EERE on how to proceed if that occurs, but noted that EERE funding is discretionary, so would be in danger of being cut back to meet the budget targets.
- Mr. Eggert asked if there was any potential for the continued funding of infrastructure activities that have a strong research component.
 - Mr. Chalk replied that the demonstrations of first-of-a-kind technology or technology innovations to reduce cost or risk are within the mission of the program.

3.2 Dr. Sunita Satyapal, Program Manager, Fuel Cell Technologies Program

Dr. Satyapal discussed the U.S. Clean Energy Patent Growth Index and the growth of the fuel cell market, noting that the number of fuel cell patents was 1,000 in 2010. This was number was three times the number of patents issued in the next closes industry (solar) and represents the significant level of investment by industry and the potential for hydrogen and fuel cells in the market. She also stated that DOE-funded efforts have reduced the projected high-volume cost of fuel cells by more than 30% since 2008, and more than 80% since 2002. In total, DOE funding has led to approximately 30 commercial technologies and more than 60 emerging technologies. DOE recently released an integrated strategic plan for research, development, and demonstration activities for its Hydrogen and Fuel Cells Program, as well as an Interagency Action Plan. A recent Request for Information is seeking feedback on the assumptions for analysis of the life-cycle costs of various vehicles, including battery electric and fuel cell electric vehicles. Dr. Satyapal noted that American Recovery and Reinvestment Act deployments of fuel cells for lift trucks led to industry purchases of an estimated 3,000 additional fuel cell lift trucks, with no DOE funding. She also mentioned that the DOE Fuel Cell Technologies Program engaged in significant communication and outreach activities over the last fiscal year, including publishing more than 70 news articles and hosting webinars and workshops, including the Natural Gas/Hydrogen Infrastructure Workshop. Dr. Satyapal also introduced Dr. Arun Majumdar, Senior Advisor to the Secretary of Energy and Director of the Advanced Research Projects Agency – Energy. Prior to joining the DOE, Dr. Majumdar was Associate Lab Director for Energy and Environment at Lawrence Berkeley National Lab and professor of mechanical engineering and material science engineering at University of California, Berkeley. Furthermore, has been a senior advisor setting strategic initiatives in a number of areas, including small companies and venture capital firms.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov2011_satyapal.pdf

3.3 Dr. Arun Majumdar, Senior Advisor to the Secretary and Director of the Advanced Research Projects Agency – Energy (ARPA-E)

Dr. Majumdar started with an overview of the DOE’s recent accomplishments, including the SunShot Initiative, the goal of which is to make solar electricity cost competitive. Dr. Majumdar stated that a key “outside-facing goal” of DOE is to enable research and development (R&D), business, and policies. A key “inside-facing goal” is to dissolve silos within the agency and integrate work across offices, thereby leveraging strengths and resources. He assured the Committee that the budget for the DOE Hydrogen Program would not be zero, but noted that federal budgets will likely be constrained for the next five to ten years. Dr. Majumdar asked the Committee for feedback on how best to use funds, noting that “it’s not a question of how much your budget is, it’s what you do with it.” He asked for ideas on activities that would catalyze industry or enable businesses to succeed in ways they would not otherwise be able to and give the U.S. private sector a competitive edge. He added that stretch goals like the Sun Shot initiative help to clearly define R&D pathways and priorities. He also noted that building infrastructure is not the DOE’s role, but funding technology that will create the infrastructure is.

Questions, answers, and discussion

- Chairman Shaw stated that the U.S. fuel cell industry is not getting the same government support that other countries’ industries receive, for example there is very little mention of hydrogen and fuel cells in the Quadrennial Technology Review (QTR).
 - Dr. Majumdar replied that the QTR is a living document; there will be future opportunities to incorporate hydrogen and fuel cells.
- Mr. van Dokkum stated that the DOE should be more cognizant of the messages it sends regarding hydrogen and fuel cells and how these impact the leverage of industry. He suggested that DOE senior managers could help to communicate the many successes in hydrogen and fuel cells, such as 10,000 hours of operation on the AC Transit fuel cell bus, and 80,000 hours of operation on a stationary fuel cell.
- Mr. Rose stated that the most sincere way to signal that the DOE supports the accomplishments of hydrogen and fuel cells would be an increase in the Hydrogen and Fuel Cells Program budget, even by a small amount. He also noted that the U.S. fuel cell industry is a billion dollar industry, so it is here and now. U.S. companies have the dominant position in combined heat and power and prime power systems, but Asian and European governments and companies are mounting aggressive efforts to take that lead away. Mr. Rose suggested the DOE help with beginning costs of fueling infrastructure because it would not be a very expensive proposition, but allow the hydrogen industry to get a foothold in the market.
- Chairman Shaw added that a study performed by the National Academy of Sciences concluded that the cost to build a hydrogen infrastructure is modest compared to the biofuels industry. The cost of buying down the whole industry on the vehicle side was \$40 billion and only \$8 billion for infrastructure. In the scheme of things, those numbers are very small. Mr. Eggert noted that California is making public investments in infrastructure, to help support the automakers’ estimates of tens of thousands of fuel cell electric vehicles being introduced into the California market in the 2015 timeframe (\$18M request for proposals in the next round of infrastructure for the State). He

estimated \$50 to \$60M to support 70 to 100 stations for this early market deployment. He asked if the DOE can fund applied R&D that contributes money to the building of refueling infrastructure that will help demonstrate station cost, performance and reliability..

- Dr. Majumdar responded that DOE does fund first-of-its-kind demonstrations or early-stage, high-risk technology that will help to catalyze private sector investment.
- Mr. Kaya suggested that the experience of state and local governments in forming public-private partnerships could be a great source of information for the department, particularly with the “soft” side of conditioning markets so they are more attractive to private investors and entrepreneurs. He noted that several of the HTAC members have experience in this area and would be happy to engage with Dr. Majumdar and his staff regarding leveraging existing deployments.
 - Dr. Majumdar agreed that the convening power of the Federal Government is very important. In one example, the Federal Government created a competition among state agencies to reduce the cost and time of permitting a solar installation, which didn’t cost much money but was very effective. He invited other ideas along these lines.
- Mr. Freese reiterated the importance of the Federal government’s messaging and its impact on the private sector and where they choose to put resources. He noted that to benefit from economies of scale, the fuel cell needs to go through at least 3 learning cycles to achieve the requisite technology maturity. This requires constancy of purpose between public and private players because it’s important to know that technology directions won’t change in a very short order. He added that DOE should focus on regional deployment strategies because it is not practical for anyone to put in a coast-to-coast infrastructure for the first launch of vehicles, but it will allow customers to be satisfied with the vehicles
- Mr. Hofmeister emphasized the importance of associating hydrogen and fuel cells with energy security and focusing on their energy storage and mobility potential. He cited 2011 as the most expensive year for gasoline in the history of the Country. He predicts that given what is known of supply and demand, when we look back 3 to 5 years from now, it will be seen as a low-cost gasoline price. He thinks hydrogen plays an important role in storing solar and wind energy, and for mobility.
 - Dr. Majumdar agreed that we definitely need a few other fuel options for transportation. He recognized hydrogen could be made from natural gas found in the U.S., but also noted there are other routes, including electricity. He pointed out the separation of transportation fuel from the global price of oil would contribute to national and economic security. He suggested using the partnership with DOD to create first markets. He welcomed thoughts for creating policy instruments that would enable use of public capital markets for energy. He noted there will be an Energy Innovation Summit in Washington, D.C. in February to include the speakers: Fred Smit, Lee Scott and Bill Gates, a panel on natural gas, and discussion on energy finance.
- Dr. Shaw stressed the importance of government support for fuel cell technologies, stating that the U.S. will lose its competitive position without it. He also stressed the

intersection between renewables and hydrogen, and the need for more focus on the possibilities it offers for integrating renewables into the energy system.

- Mr. Chalk and Dr. Satyapal will soon go to Germany to visit a wind-to-hydrogen storage facility in conjunction with the IPHE meeting. He offered to brief the Committee on this trip at the next meeting.

4. Impact of Larger Natural Gas Supply on Fuel Cell and Hydrogen Market, Larry Burns

Mr. Burns outlined how hydraulic fracturing has created an abundance of low-cost natural gas in the United States, and stated that the country should use this windfall to address multiple strategic objectives. For example, using shale gas to reduce oil imports could have significant strategic value. He also suggested that shale gas could be used to retire old coal power plants, supply compressed natural gas for economically viable commercial fleet applications, supply electricity for plug-in vehicles and hydrogen for fuel cell electric vehicles, and develop integrated energy systems alongside renewable energy. Mr. Burns remarked that shale gas exploration and production must meet codes and standards that address the environmental risks associated with hydraulic fracturing. He noted that DOE should play a multifaceted role in facilitating the country's wise and responsible use of shale gas.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov2011_burns.pdf

Questions, answers, and discussion

- Mr. Eggert asked which policy mechanisms need to be pursued in order to allow for more investment.
 - Mr. Burns stated that policy becomes distorted when industry and government take a technology to scale before it has gone through three commercial learning cycles. Rather, he said, we should push several technologies to the tipping point and let the market take over.
- Chairman Shaw asked for Mr. Burns' opinions on the gas industry's response to public concerns over hydraulic fracturing.
 - Mr. Burns responded that it is important for industry to create a set of best practices and codes and standards as quickly as possible so that companies engaged in fracking have clear and safe operating guidelines.
- Dr. Taylor stated that she doesn't see a push to reduce fuel oil usage, a significant energy source in the Northeast.
- Chairman Shaw asked Mr. Burns to comment on worldwide hydrogen and fuel cell technology progress.
 - Mr. Burns stated that hydrogen and fuel cell technologies for automobiles are on track and he is impressed with recent progress.

5. Entrepreneurial Presentations

5.1 Gary Flood, ReliOn, Inc

Mr. Flood noted an increase in worldwide adoption of fuel cells for backup power applications and as a component of energy management. He also mentioned the substantial cost reductions and density improvements that have been achieved in their third generation commercial product. He described two case studies of fuel cell usage for back-up power involving AT&T and the Washington State Patrol. Mr. Flood then remarked that hydrogen fuel cells are challenged by incumbent solutions, alternative new technologies, and a need for national and state policies that would help to create and sustain momentum. As a fuel, hydrogen faces distribution, cost, and regulatory barriers. Mr. Flood noted that while fuel cells are not a panacea, they can ably serve as a backup power source, grid supplement, or hybrid with other power sources and storage systems.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov2011_relion.pdf

Questions, answers, and discussion

- Mr. Freese asked if R&D investments in the automobile sector are being leveraged to decrease costs for ReliOn's stacks.
 - Mr. Flood responded that ReliOn benefits indirectly from some of the work of the auto industry, such as in the reduction of catalyst loading.

5.2 Sanjiv Malhotra, Oorja Protonics, Inc. & Mike Muzyk, President of Baldor Foods

Mr. Malhotra first discussed some of the key early challenges faced by fuel cells in the areas of technology, market, and economics, and how Oorja's fuel cell system has overcome them. He then introduced the OorjaPac™ Model 3, which is a 1.5-kilowatt liquid fuel cell that operates as an onboard battery charger for material handling applications. Oorja has shipped more than 500 of these direct methanol fuel cell systems during the past three years, and has a backlog of more than 200 systems. Mr. Malhotra detailed the advantages that the OorjaPac™ has over hydrogen fuel cells and lead acid batteries, including in runtime between charges, battery life, and infrastructure cost. He explained that Oorja uses methanol because it is very widely available, and stated that Oorja's total addressable market is \$30 billion.

Mr. Malhotra also introduced Mike Muzyk, President of Baldor Foods, who after testing the Oorja fuel cell lift truck, decided to purchase 50 units for his produce distribution center in New York. Baldor Foods is a 700-person company that runs 200 lift trucks. Mr. Muzyk enthusiastically stated that his produce company has been using Oorja fuel cell lift trucks with great success. He has had a lot of experience burning out batteries regardless of policies put in place. He added that the reliability and quick refueling time make them "priceless," especially considering that he relies on the lift trucks to load 200 trucks daily, one pallet every minute. He wants to dominate the market and intends to introduce fuel cells to a lot his competitors, as well as the meat and fish industry in the Bronx and Hunts Point areas, "You guys are absolutely passionate about fuel cells. I can tell you that right now...But, I know produce, okay? I'm passionate about that. So, we're going to buy some fuel cells."

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov2011_oorja_protonics.pdf

Questions, answers, and discussion

- Dr. Thompson asked Mr. Malhotra to elaborate on the technical details of their system's improved durability.
 - Mr. Malhotra stated that they were able to reduce crossover through a combination of materials enhancement and electrode morphology. He added that Oorja Protonics outsources the production of their MEAs.

Questions, answers, and discussion on both presentations

- Mr. Freese asked if either presenter worries about the toxicity of methanol.
 - Mr. Malhotra responded that they have taken great care to make sure this isn't an issue. Operators do not have contact with the methanol and their facility undergoes extensive safety testing.
- Mr. Koyama asked both presenters what it would take to substantially increase the use of fuel cells and how the DOE can help.
 - Mr. Flood responded that the DOE's Market Transformation subprogram has greatly accelerated the growth of fuel cells in the market. DOE should continue to work on messaging and talk about industry successes, focusing on areas with the most impact.
 - Mr. Malhotra said that industry needs to focus on profitability and emphasize the return on investment of fuel cells.

6. HTAC Annual Report Planning

Mr. Bond led a discussion on the 2011 HTAC Annual Report, now under production. Committee members shared their input on approach, categories, content, and order of topics. Members also debated the level of detail that should be included in the report and agreed that the report should not shy away from the challenges that the hydrogen and fuel cell industry faces. Mr. Bond urged members to submit their recommendations of topics to include in the report as soon as possible.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_nov2011_annual_report.pdf

Questions, answers, and discussion

- Mr. van Dokkum and Mr. Kaya will join the Annual Report team. The team will work with Mr. Novachek to develop the score card for inclusion in the report.
- All HTAC members will send input to Mr. Bond as soon as possible.

7. Batteries and Charging/Infrastructure

7.1 Vehicle Battery Cost and Performance Status, David Howell, Team Lead, Hybrid Electric Systems, Vehicle Technologies Program, DOE

Mr. Howell gave a brief overview of vehicle electrification and its benefits, and stated that battery affordability and performance are essential for achieving significant market penetration. He explained the overarching DOE goal of achieving a battery cost of \$.01 per mile (in terms of battery cost divided by total electric miles driven). This goal addresses consumer concerns about battery life and costs. Other goals include producing batteries that are safe and can achieve 10 miles per minute of fast charge. Mr. Howell stated that DOE R&D efforts have a track record of successfully developing batteries for electric-drive vehicles, citing how those efforts helped to bring nickel-metal hydride and lithium-ion batteries into the automotive market. He described some of DOE's advanced materials research, and stated that DOE R&D is on track to meet its 2015 cost and performance targets. There are also technologies in the pipeline that go beyond 2015.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov2011_howell.pdf

Questions, answers, and discussion

- Mr. van Dokkum asked for clarification on the difference between cost and price as used in Mr. Howell's presentation.
 - Mr. Howell stated that the cost models are based on a manufacturing facility optimized to run 24/7 and produce 100,000 battery packs per year, but do not include warranty and profit.
- Chairman Shaw asked Mr. Howell to comment on the current price of the plug-in hybrid electric vehicle (PHEV) and battery electric vehicle (BEV) battery packs.
 - Mr. Howell responded that at low volumes, the batteries will cost around \$1,000 per kilowatt-hour.
- Mr. Eggert asked if the DOE models the compared costs of fuel cells and batteries.
 - Mr. Howell responded that this is difficult given differences in the technologies. However, Dr. Satyapal added that there is an opportunity to do some of this type of comparative analysis.

7.2 Vehicle Battery Charging Cost, Lee Slezak, Vehicle Systems, Vehicle Technologies Program, DOE

Mr. Slezak first compared the different types of electric vehicles currently on the road in terms of battery characteristics, vehicle operation, and economy. He then detailed the standards, charge times, and charger costs for the AC Level 1, AC Level 2, and DC Level 2 charging methods. He stated that a cost-benefit analysis shows that the average Nissan Leaf owner does not have a financial incentive to pursue residential ownership of current-generation commercial fast chargers. However, for higher-mileage commercial drivers, DC Level 2 charging enables the Nissan Leaf to achieve much shorter charging times and better pay back on a cost-per-mile basis. Mr. Slezak also stated that the value proposition for public electric vehicle charging infrastructure is unclear. DC fast charging is most suitable for public infrastructure, but the cost is too high. He noted that state public utility commissions (PUCs) generally do not allow entities other than regulated utilities to charge for electricity, so recovering costs would be difficult for other types of businesses. He also noted that plug-in electric vehicles can leverage the infrastructure of the pre-existing U.S. electricity grid; the only new infrastructure required is the EV chargers. As the

grid becomes increasingly powered by renewable or low-carbon resources, PEVs will offer a practical pathway to achieving lower greenhouse gas emissions.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov2011_slezak.pdf

Questions, answers, and discussion

- Mr. Kaya asked Mr. Slezak to expand on the issues surrounding charging infrastructure and associated regulations or restrictions from the state public utilities commission. He also asked if he sees a need for working with state PUCs to address these issues.
 - Mr. Slezak responded that the reselling of electricity is lower on his list of priorities than addressing the cost and time for permitting of EV charger installations.
- Mr. Rose asked if the individual EV charger purchaser is responsible for equipping his or her house with the proper vehicle charging equipment.

Mr. Slezak responded that it is indeed the consumer's responsibility. He noted that his office has been working with utilities and state and municipal organizations to develop a mechanism for notifying utilities about EV charger installations, and coordinating this so that there are not deleterious impacts on the grid or individual transformers. If grid upgrades are needed to accommodate a large number of EV chargers, then this would be paid for by the utility. Mr. Novachek noted that this cost of grid upgrades would be indirectly paid for by consumers since it would be included in the utility's rate base. He added that this cost may not be insignificant, given that many components of a given grid system may already be at or nearing their limit, and this cost should be included in any analysis that compares the costs of EVs with other vehicles.

7.3 Comparison of Electric Charging and Hydrogen Infrastructure Costs, Sandy Thomas, Clean Energy Consultant

Dr. Thomas presented comparisons of hydrogen infrastructure costs per fuel cell electric vehicle deployed, noting that the average initial cost is \$3,200 and the future cost estimate is \$1,200. He then discussed electrical infrastructure costs, noting the wide variation in costs that three companies and the state of Hawaii paid to install Type II 240-volt outlets. Based on these figures and the Electrification Coalition recommendation of having at least two outlets per vehicle, he concluded that Type II electrical outlets cost between 5.2–14 times more than hydrogen stations per vehicle. He then shared projections from the McKinsey report on cumulative infrastructure costs over 40 years for installing hydrogen fueling stations (€101 billion) and outlets (€540 billion) across Europe, as well as decarbonizing the grid (€1.3 trillion). He also shared average annual infrastructure cost projections.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov2011_thomas.pdf

Questions, answers, and discussion

- Mr. Novachek observed that the numbers he has seen in the previous presentations seem to be very optimistic, given everything he's read and heard about the potential for reducing battery costs.

- Mr. Howell responded that the costs presented by DOE are projections based on technology that is currently in the R&D stage, and that the goals are stretch goals. Dr. Shaw noted that there are some interesting new battery materials being tested, but there are significant challenges that need to be resolved before they are commercialized, including passing durability and safety tests. He noted that a recent report by the National Research Council (NRC) (“Transition to Alternative Transportation Technologies – Plug-in Hybrid Electric Vehicles,” 2010) characterized many of these risks and costs. Mr. Howell agreed with Dr. Shaw that the conclusions drawn from this study are still valid.
- Dr. Satyapal added that there were some differences between the NRC and DOE assumptions, in terms of the projected rate of cost reductions and the current battery costs.

7.4 OEM Perspective, Britta Gross, General Motors

Ms. Gross opened her presentation by stating that a portfolio of solutions, including batteries and fuel cells, is necessary to reduce petroleum use. She stated that significant progress has been made in switching from lead-acid batteries to nickel-metal hydride batteries to lithium-ion batteries. She then described the Chevy Volt, which can travel 40 miles on battery power and more than 300 additional miles on gasoline. Ms. Gross noted that, for the Volt, residential charging is more important than workplace or public charging because the vehicles spend the most time at home. Volt owners can plug a 120-volt charger directly into a household outlet or upgrade to a 240-volt unit. She also detailed GM’s Project Driveway program, in which 80 mainstream drivers use GM fuel cell vehicles for their everyday driving needs. The program features more than 1,980 hours driven on single vehicle systems, and has reduced carbon dioxide emissions by 1.7 million pounds.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_nov2011_general_motors.pdf

Questions, answers, and discussion

- Dr. Taylor asked about the percentage of people with homes and garages suitable for installing 240-volt vehicle charging stations.
 - Ms. Gross responded that the target market for these vehicles is single family homes with garages or other dedicated charging space.

DAY 2 – NOVEMBER 4, 2011

8. Financing HFC Technologies, Jan van Dokkum, Facilitator

Mr. van Dokkum presented several graphs depicting recent trends in DOE and private sector spending on hydrogen and fuel cell investment over the past several years and highlighted the fact that both sectors have reduced spending in the last three years. Mr. van Dokkum also displayed a graph showing that fuel cell industry research and development (R&D) spending decreased between 2008 and 2010. He states that overall, the DOE spending has actually been fairly stable

over the years, but we see a ‘tail-off’ in the private sector, which is ‘dangerous’. He shared employment data that showed minimal change in fuel cell and hydrogen infrastructure jobs between 2007 and 2011, with forecasts of substantial growth between 2020 and 2050. Mr. van Dokkum also illustrated the correlation between DOE spending and U.S. intellectual property patent filings in the fuel cell industry.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov2011_financing.pdf

Questions, answers, and discussion

- Mr. Eggert asked if Mr. van Dokkum had ever compared the public and private spending trends on batteries.
 - Mr. van Dokkum replied that public and private investments in battery research are equal to each other and have been growing significantly in the last few years.
- Mr. Cardillo asked about international spending trends.
 - Mr. van Dokkum stated that investment in fuel cells and hydrogen infrastructure in Japan, China and Korea has significantly increased recently but spending is steady in Europe.

8.1 Financing H2 and Fuel Cell Opportunities—A Venture Capitalist’s Perspective, Maurice Gunderson, Managing Director, Earth Energy Ventures

Mr. Gunderson began by stating that nearly zero commercial successes have come out of the many VC investments in the sector. He defined commercial success as selling enough product at positive gross margins to increase the value of the company. He claimed that the hydrogen and fuel cell sector stands alone in terms of exaggerating claims and timeframe in the view of the VC community. . He recommended that companies base their business on solid scientific facts, while also being enthusiastic and credible. He suggested fuel cell business concentrate on the premium power sector rather than trying to compete with the grid in order to charge a high price for applications that provide the highest possible value. Mr. Gunderson noted that companies should also look for funding sources that match their stage of development. Venture capitalists have specific timing requirements that might not always align with a company’s growth (99% of VC is in a 10-year funding structure). He remarked that energy technology advances are often triggered by materials advances, and thus encouraged companies to concentrate on materials advancements, especially those that have multiple high-value applications

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov2011_gunderson.pdf

Questions, answers, and discussion

- Mr. Hoffmeister asked Mr. Gunderson to give specific examples of what he considered hyperbolic claims made by the hydrogen and fuel cell industry.
 - Mr. Gunderson stated that people often claim it is a \$1 billion industry. While \$1 billion may have been spent by car companies on development work, it is misleading to state that the business expansion capital is worth this much.
- Mr. Koyama asked if Mr. Gunderson if he feels fuel cells are a good investment opportunity.

- Mr. Gunderson replied that his company has invested in fuel cells. The industry is becoming more investable, especially high-value products such as fuel cells for military applications.
- Dr. Thompson asked if high-value, premium power markets mentioned by Mr. Gunderson as being the best investment opportunities are actually big enough to attract significant venture capital.
 - Mr. Gunderson responded in the affirmative.

8.2 Sanjiv Shrestha, Financial Banking Expert, Managing Director and Senior Analyst, Lazard Capital Markets

Mr. Shrestha stated that the fuel cell sector holds great promise, but is not receiving investor attention. He remarked that this valuation discrepancy can be partially blamed on the global economic climate and overall sector sentiment, but the lack of national policy support is largely to blame. Investors are unsure whether demand for fuel cell energy will be sustained. He stated that the path to commercial success remains unclear, and that there are misperceptions about fuel cell technology. Mr. Shrestha also predicted that fuel cell subsidies from the government would not only jumpstart the industry, but also level the playing field and mediate some of the crisis related issues. He also stated that government and the private sector together need to focus on bankability, standardization, and reliability. He noted the need to let the best technology win, and stated that energy policy cannot be a political issue—it is a national security issue.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov2011_shrestha.pdf

Questions, answers, and discussion on both presentations

- Chairman Shaw stated that the behavior of markets influences whether or not venture capitalists actually make money in fuel cell technologies; timing is important. Fuel cells technologies are a long term investment and most venture capitalists cannot afford to wait that long. Therefore, without government investment, most businesses will not survive.
- Mr. Kaya asked both presenters if they have any ideas on how the DOE can facilitate investment.
 - Mr. Gunderson stated that he appreciates the DOE's willingness to invest in new forms of energy but it is difficult to compete with China and Germany given that our government structure does not allow for long term commitments.
 - Mr. Shrestha added that we need national policy for long term investment in technology.
- Mr. Cardillo added that the role of government regulation is often overlooked. China, for example, was able to bolster their solar industry by blocking the importation of solar-power technologies until their companies became competitive.

9. Public Comment Period

9.1 John Michael Parkan, Documentary Film Maker

Mr. Parkan screened a trailer for the film he is making that promotes the use of hydrogen as a transportation fuel.

9.2 Estimates of BEV and PHEV Market Penetration, Dr. Sandy Thomas, Clean Energy Consultant

Dr. Thomas gave a presentation on the potential market penetration of both battery electric vehicles and plug-in hybrid electric vehicles. His analysis showed that even in the near term, fuel cell vehicles have an advantage over PHEVs and BEVs in terms of greenhouse gas emissions and oil consumption.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_nov2011_comment_thomas.pdf

Questions, answers, and discussion

- Mr. Kaya asked if Dr. Thomas believed the White Houses' target greenhouse gas reduction of 80% by 2050 was achievable with BEVs and PHEVs alone.
 - Dr. Thomas replied that he does not believe this target will be achieved with BEVs and PHEVs alone.
- Mr. Eggert added that the California Council on Science and Technologies did a scenario analysis called "California's Energy Future, the View to 2050" which concluded that the target is plausible with new innovation and 60% reduction is plausible through the use of existing technologies, including hydrogen and fuel cells.

9.3 South Carolina's Hydrogen and Fuel Cell Initiatives, Dr. Shannon Baxter-Clemons, Director, South Carolina Fuel Cell Partnership

Dr. Baxter-Clemmons gave an overview of the South Carolina Hydrogen and Fuel Cell Alliance (SCHFCA), a nonprofit public-private organization that coordinates state resources in order to commercialize hydrogen and fuel cells in South Carolina. She noted that the state has 229 jobs in organizations directly involved in using hydrogen and fuel cells for alternative energy, and 8 hydrogen and fuel cell start-up companies. Dr. Baxter-Clemmons also remarked that state hydrogen investment has been leveraged at a rate of more than 10 to 1. She described the case studies that SCHFCA has produced to demonstrate examples of successful deployments to potential customers, and explained that South Carolina is the first state to permit hydrogen and fuel cell deployments at the state level using existing internationally recognized codes and standards. South Carolina also has a sales tax exemption and Hydrogen Infrastructure Development Fund that encourage investment.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_nov2011_south_carolina.pdf

Questions, answers, and discussion

- Dr. Satyapal stated that DOE funded several hydrogen and fuel cell deployments in South Carolina and asked how the program can keep up the momentum as funding comes to a close.

- Dr. Baxtor-Clemens stated that the DOE's role as a buyer of products has been a huge boon to fuel cell manufacturers. Yet beyond funding, the most helpful thing DOE can do is provide verbal support for the industry through messaging and partnership.

10. Working Group Updates

10.1 Hydrogen Enabling Renewables Working Group, Frank Novachek, HTAC member

Mr. Novachek discussed the purpose of the Working Group and stated that the group is initially focusing on grid energy storage applications. He noted that work on this topic aligns with DOE interests and could be leveraged in analyses of other activities. Mr. Novachek then discussed how energy storage could address variability in wind and solar power generation, such as by matching the load on a system and reducing generator cycling. The Working Group has made progress on its assigned tasks, including working toward developing a model for examining the basic economics of hydrogen energy storage. The group is also accumulating results from relevant economic studies on other energy storage technologies. Mr. Novachek presented key variables for 50% renewable energy penetration scenarios, such as the cost of carbon.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_nov2011_renewables_wg.pdf

Questions, answers, and discussion

- Mr. Cardillo suggested that any analysis that comes out of the HTAC be coordinated with the DOE in order to present one message.
 - Mr. Novachek responded that the HTAC and working group is not publishing DOE-sanctioned analysis, but rather generating information that may lead the DOE to do their own analysis and/or validation.
- Dr. Carlin offered to send a report on Smart Grid and energy storage in Europe from Dr. Sara Cerri.
- Mr. Freese stated that unlike the working group's model, the European models include hydrogen as a transportation fuel.
 - Mr. Novachek responded that the working group initially analyzed energy storage because of the uncertainty of the hydrogen vehicle market. Proving the feasibility of hydrogen for energy storage was a good way to get a foothold on the hydrogen space while fuel cell vehicles were being developed.
- Mr. Rose asked about natural gas pipelines as an energy storage option.
 - Dr. Carlin will share a paper on this technology.
- Mr. Hofmeister stated that he would like to see more about engaging state public utility commissions.
 - Mr. Novachek agreed.
- Mr. van Dokkum suggested the Committee speak with Emory Cook or Mark Johnson from the DOE regarding comparative analysis between hydrogen and fuel cells and other competitive new technologies now emerging in the marketplace.

10.2 Hydrogen Infrastructure Sub-Committee Report, Kathleen Taylor, HTAC working group member

Dr. Taylor gave an overview of recent developments in the hydrogen infrastructure field. She discussed R&D announcements for hydrogen storage, hydrogen compression, and liquefaction, including work on new materials such as microfibers. She noted that DOE continues to be a major funder of R&D for hydrogen storage technologies. She then mentioned hydrogen source developments, emphasizing Hydrogenics' worldwide electrolyzer sales and the Linde syngas plant scheduled to open in China in 2014. Dr. Taylor reviewed recent news concerning hydrogen fueling station installations and networks, pointing out a project in Japan to put pipelines in an urban area. She also discussed some related studies, including one study on hydrogen purification units for refueling. In closing, Dr. Taylor mentioned that fuel cell shipments continue to increase and applications are expanding beyond demonstration to meet energy demands.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_nov2011_infrastructure_wg.pdf

Questions, answers, and discussion

- Mr. Thompson suggested Dr. Taylor convert the number of shipments listed in her presentation to number of watts installed.
 - Dr. Satyapal added that there has been a 40% growth in megawatts of fuel cells shipped between 2009 and 2010 but the number of units shipped remained flat.
- Mr. Hofmeister asked if Dr. Taylor came across any accidents or other incidences as she tracked fuel cells.
 - Dr. Taylor did not know of any.
 - Dr. Satyapal added that the FCTP has a national hydrogen and fuel cells incident database that now includes some international incidents from the European Commission as well.

**FIFTEENTH MEETING OF THE
HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE**

PARTICIPANT LIST

November 3-4, 2011

HTAC Members Present

- Peter Bond
- Mark Cardillo
- Richard Carlin
- Anthony Eggert
- Charles Freese
- John Hofmeister
- Maurice Kaya
- Harol Koyama
- Frank Novachek
- Bob Rose
- Bob Shaw
- Levi Thompson
- Jan van Dokkum
- Bill Wylam

HTAC Members Not Present

- Alan Lloyd
- Joan Ogden
- Geraldine Richmond

U.S. Department of Energy Staff

Office of Energy Efficiency and Renewable Energy

- Steve Chalk
- Sara Dillich
- Kathi Epping Martin
- Rick Farmer
- John Garbak
- Nancy Garland
- Donna Ho
- David Howell
- Fred Joseck
- Jason Marcinkoski
- Grace Ordaz
- David Peterson
- Sunita Satyapal
- Lee Slezak
- Ned Stetson

Advanced Research Projects Agency – Energy (ARPA-E)

- Dane Boysen
- Arun Majumdar

Members of the Public in Attendance

- Shannon Baxter-Clemmons – South Carolina Hydrogen & Fuel Cell Alliance
- Gary Flood – ReliOn, Inc.
- Leo Grassilli – D&L Energy Consulting
- Britta Gross – General Motors
- Maurice Gunderson – Earth Energy Ventures
- Cassidy Houchins – SRA International, Inc.
- Sanjiv Malhotra – Oorja Protonics, Inc.
- Bill MacLeod - Hyundai
- Carter Marantette – ReliOn, Inc.
- Stafford Matthews – SNR Denton
- James Miller – Argonne National Laboratory
- Michael Muzyk – Baldor Specialty Foods, Inc.
- Don Pacholec – Oorja Protonics, Inc.
- John Parkan – Providence Entertainment
- Bryan Pivovar – National Renewable Energy Laboratory
- Sanjay Shrestha – Lazard Capital Markets
- Raj Singh – Oorja Protonics, Inc.
- Kathleen Taylor
- Sandy Thomas – Consultant
- Stephen Welke – Providence Entertainment
- Chris White – California Fuel Cell Partnership
- Neil Popovich – National Renewable Energy Laboratory

Support Staff

- Judi Abraham – Conference Management Associates, Inc.
- Kristine Babick – Energetics Incorporated
- Melissa Laffen – Alliance Technical Services, Inc.
- Shawna McQueen – Energetics Incorporated
- Tom Timbario – Alliance Technical Services, Inc.