

HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE

MEETING MINUTES

November 15–16, 2012

National Renewable Energy Laboratory, Washington, DC

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DAY 1 – NOVEMBER 15, 2012

1. Public Comment Period

1.1 Jeff Serfass, Managing Director, California Hydrogen Business Council (CHBC) and President, Technology Transition Corporation

Mr. Serfass spoke on the work of the CHBC which includes four main projects: 1) assisting in the rollout of the California Hydrogen Highway, 2) expansion of the Self-Generation Incentive Program (SGIP) for distributed power generation including hydrogen and fuel cells, 3) expansion of the SGIP for fuel cell lift trucks, and 4) hydrogen for energy storage. Mr. Serfass also spoke about the work of the Hydrogen Education Foundation and the 2012-2013 student design contest to create a feasible plan for the implementation of hydrogen infrastructure using commercially available technology designed to facilitate fuel cell vehicle travel in the Northeast and Mid-Atlantic. The contest now includes 24 registered teams from all over the world. He asked anyone interested in acting as a judge to contact him directly or through the DOE.

Questions, answers, and discussion

- Chairman Hofmeister asked if any major oil companies are involved in either the California Hydrogen Business Council or the Hydrogen Education Foundation's student design contest.
 - Mr. Serfass stated that there are no major oil companies involved in either group.
- Chairman Hofmeister asked if the groups in question were involved with Western States Petroleum Association (WSPA).
 - Mr. Serfass stated that they are not but acknowledged that they could be.
- Chairman Hofmeister asked Mr. Serfass to characterize the moods of the members of the California Hydrogen Business Council.
 - Mr. Serfass responded that the members are very engaged and upbeat. Furthermore, membership around the country is growing. Their main concerns are infrastructure development and fuel cells for stationary power. Regarding infrastructure, the group is working with the Bay Area and South Coast Air Quality Management District as well as the California Air Resources Board with funding from the California Energy Commission. Mr. Serfass added that station investment and deployment is originating from a diverse group of parties, including gas companies, OEMs, and universities. Oil companies are expected to become involved when the market matures but the main issue has become securing funding during the transition period.
- Dr. Thompson asked Mr. Serfass to comment on natural gas as a threat to the widespread use of hydrogen.
 - Mr. Serfass stated that he is encouraged by what he sees as a growing acceptance of producing hydrogen from natural gas while the cost of renewably-produced hydrogen continues to decrease.
- Mr. Serfass added that he is the content manager for the Total Energy USA conference in Houston, November 27 to 29. Dr. Shaw and Mr. Hofmeister are both on the executive committee for the event.

1.2 **Morry Markowitz, President and Executive Director, Fuel Cell and Hydrogen Energy Association (FCHEA)**

Mr. Markowitz spoke about the activities of the FCHEA in enhancing the visibility of hydrogen and fuel cells in Congress, especially through work with the House and Senate Fuel Cell Caucuses. Mr. Markowitz's group sponsored a caucus launch event this past summer and they are working to expand bipartisan membership in both caucuses. They plan to continue educating Congressional offices and promoting hydrogen and fuel cell technology.

Questions, answers, and discussion

- Chairman Hofmeister asked if the election affected the membership of FCHEA.
 - Mr. Markowitz responded that the election did not result in any changes to the membership.
- A spectator asked Mr. Markowitz's opinion on the reason for a renewed interest in hydrogen.
 - Mr. Markowitz stated that FCHEA member companies have helped reenergize Congressional interest in hydrogen and fuel cells by speaking with elected officials.

2. DOE Update

2.1 **Fuel Cell Technologies Update, Dr. Sunita Satyapal, Program Manager, Fuel Cell Technologies Program, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy**

Dr. Satyapal provided a summary of recent Fuel Cell Technologies (FCT) Program activities and highlights. She gave an overview of the FCT Program and explained that FCT Program funding has led to 363 patents, 35 commercial technologies, and 65 emerging technologies. She also remarked that the FCT Program has published more than 70 news articles in 2012, developed educational materials, and educated more than 9,600 teachers and more than 23,000 code officials and first responders on hydrogen and fuel cells. She noted that the \$1 million prize from the storage H-Prize remains available for future competitions, and she also talked about potential prizes in a "Transformational Technologies" category. Dr. Satyapal discussed the Hydrogen and Fuel Cell Technical Advisory Committee's Hydrogen Production Expert Panel (HPEP) workshop and noted that HPEP recommendations are being implemented, such as the creation of a DOE-wide Fuel Cell "Tech Team" in response to the HPEP recommendation to establish and maintain communications between DOE entities. She also mentioned the work of Dr. Thomas Jaramillo of Stanford, the first ever EERE recipient of the prestigious Presidential Early Career Award for Scientists and Engineers.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_nov12_1_satyapal.pdf

2.2 **EERE Update, Dr. David Danielson, Assistant Secretary, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy**

Dr. Danielson gave an overview of the U.S. Department of Energy (DOE) Office of Energy Efficiency (EERE), with a particular focus on its efforts related to hydrogen and fuel cells. He shared EERE's mission—to create American leadership in the global transition to a clean energy economy. He also described EERE programs and activities, which address advanced manufacturing technologies that fall under the categories of

sustainable transportation; renewable electricity generation; and energy-saving homes, buildings, and manufacturing. Dr. Danielson reviewed the Five EERE Core Questions: 1) Is this a high impact problem? 2) Will the EERE funding make a large difference relative to what the private sector (or other funding entities) is already doing? 3) Have we made sure to focus on the broad problem and be open to new ideas, approaches, and performers? 4) How will this EERE funding result in enduring economic benefit to the country? 5) Why is this work a proper high impact role of government versus something best left to the private sector? Dr. Danielson noted that EERE's priorities are in transportation, integration, and manufacturing competitiveness. He also stated that EERE will be reorganized around sectors and the FCT Program, Vehicles Program, and Biomass Programs will all fall under a new Deputy Assistant Secretary of Transportation. He stated that DOE has supported research and development that has reduced the cost of automotive fuel cells by more than 83% since 2002 and 35% since 2008. Dr. Danielson shared other EERE perspectives on fuel cells and hydrogen, remarking that shale gas presents a game-changing opportunity for inexpensive hydrogen production. He also stated that there is a need for private-sector leadership of a strong, public-private partnership on hydrogen fueling infrastructure and strategic early markets will help enable longer-term success. He also noted that EERE's fiscal year (FY) 2012 budget is \$1.8 billion, and he detailed EERE's FY 2013 budget requests for different focus areas as well as the FY 2013 House and Senate marks for those areas.

>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_nov12_2_danielson.pdf

Questions, answers, and discussion directed at both speakers

- Dr. Shaw asked Dr. Danielson to comment on DOE strategy for dealing with potential cuts in the FCT Program budget.
 - Dr. Danielson responded that the Department supports hydrogen and fuel cell technologies as part of its all-of-the-above energy strategy. EERE is also increasing its engagement of Congress through its Strategic Programs Office. He went on to state that the Department can improve communication with stakeholders, especially in the area of articulating successful returns on investment as well as manufacturing competitiveness.
 - Dr. Shaw followed up by asking if the successes are resonating with members of Congress.
 - Dr. Danielson stated that it is too early to tell and it is important to continue to articulate the importance of clean energy.
- Dr. Ogden suggested forming a public-private partnership to examine hydrogen infrastructure strategy. She also stated her belief in the importance of examining transportation as a field that encompasses many different technologies and encouraged the DOE to focus on economic benefits.
 - Dr. Danielson stated that the majority of infrastructure funding will come from the private sector and there may be an opportunity to align with the natural gas market.
- Dr. Bond asked if EERE will leverage the work of other DOE offices such as the Office of Science.
 - Dr. Satyapal stated that the FCT Program works closely with other offices in the DOE. For example, the Office of Basic Energy Science provides \$34 million for projects related

- to hydrogen and fuel cells. The new DOE-wide Fuel Cell Tech Team will also help with coordination and leveraging of resources.
- Dr. Danielson asked the group for feedback regarding whether funding should be focused on refining current and near-term technologies or whether it should be directed at longer-term technologies.
 - Mr. Rose stated that internationally, investment is increasing in market transformation, infrastructure deployment, large-scale natural gas reforming, and hydrogen for energy storage. These are all areas that receive very little funding from the DOE.
 - Dr. Danielson asked for recommendations from the Committee on how the DOE's competitive strategies compare to those of other countries, especially with regards to manufacturing.
 - Mr. Triompo asked how the DOE is working with state governments, especially in regards to grid integration and modernization.
 - Dr. Danielson commented that grid integration is a good example of DOE cross-cutting and specifically called out the Energy Systems Integration Facility at the National Renewable Energy Laboratory (NREL). He stated that he welcomes feedback from the Committee on how fuel cells and hydrogen can be used in grid integration.
 - Chairman Hofmeister stated that whereas gasoline used to be the sole type of vehicle fuel, there is now competition between gasoline and other types of fuel. Yet major oil companies have very little interest in moving away from their competitive monopoly. He stated that a forum is needed for all the major infrastructure and fueling decision makers to come together.
 - Dr. Danielson responded that the DOE is valued as a convening authority and may be able to put together a forum around broad transportation opportunities and challenges.
 - Dr. Ogden added that the infrastructure work being done by the DOE is a prime example of the DOE playing a convening role and could be equally successful with alternative fuels.
 - Chairman Hofmeister added that the majority of desirable real estate for fueling stations is already in use and there is resistance to infrastructure modification due to space limitations.
 - Dr. Shaw stated that station owners will be more likely to make modifications if it is financially desirable to do so.
 - Dr. Lipman referenced California's Clean Fuels Outlet Regulation, which requires major oil companies to build fueling infrastructure once the prevalence of vehicles hits a certain threshold.
 - Dr. Thompson stated that he is cautious of overcapacity caused by government incentives and the fallout that results when the incentives expire. He cited the Michigan battery industry as an example.
 - Mr. Taylor stated that it is important to launch infrastructure in concentrated areas rather than spreading it too thin geographically.
 - Mr. Freese stated that infrastructure growth is slowed by a lack of incentives for first adopters. He suggested the DOE create a roadmap that strategizes infrastructure development through the next 20 years.
 - Dr. Shaw asked how carbon regulation would affect hydrogen from natural gas and suggested the potential convening process mentioned earlier to address this issue.

- Mr. Rose asked how the FCTP is dealing with the Continuing Resolution in effect through March.
 - Dr. Satyapal stated that for the first six months of the fiscal year the program is restricted to 29% of the lowest potential total annual budget. In this case it would be the DOE request of \$80 million; the Senate mark was \$104 million and the House mark was \$82 million. Furthermore, there are restrictions on the transferring of funds across sub-programs.
- Chairman Hofmeister stated that he would draft a letter for Dr. Danielson thanking him for his participation and summarizing the discussion.

3. Approval of HTAC meeting minutes

Dr. Shaw moved to approve the minutes from the September and May HTAC meetings. Minutes were approved without comment.

4. Video Presentation by United States Senator Richard Blumenthal and follow up discussion

A short video was played that featured comments by Senator Blumenthal of Connecticut. Senator Blumenthal is the co-chair of the Senate Fuel Cell and Hydrogen Caucus. Mr. Markowitz of FCHEA was asked to answer questions related to the Caucus.

Questions, answers, and discussion

- Dr. Shaw asked about the makeup of the Caucus' members.
 - Mr. Markowitz responded that the Caucus is co-chaired by Senator Blumenthal, Senator Koonz of Delaware, Senator Hoevan of North Dakota, and Senator Graham of South Carolina. The Caucus is made up of nine Democrats and two Republicans, in addition to the two co-chairs from each party. FCHEA meets with the Caucus staff regularly and three of the four co-chairs were present at the launch event.
- Dr. Shaw encouraged members of the Committee to meet with their elected officials about hydrogen and fuel cells but cautioned that members cannot act as representatives of the Committee when doing so.
 - Mr. Markowitz offered to supply a complete list of Caucus members to the Committee.

5. Hydrogen Infrastructure Cost Estimates and Blending Hydrogen into Natural Gas Pipelines, Dr. Marc Melaina, Senior Engineer, National Renewable Energy Laboratory (NREL)

Dr. Melaina discussed hydrogen infrastructure cost estimates and the concept of blending hydrogen into natural gas pipelines. He first noted that two recent NREL reports have addressed the topic of hydrogen station costs using new inputs from the Hydrogen Station Cost Calculator (HSCC). He discussed a report comparing HSCC results to other estimates of station costs, as well as costs for stations installed in California. He mentioned that HSCC results were applied to a Northeast Corridor rollout scenario. He also noted that new data suggest the possibility of significant infrastructure cost reductions in the near term. In addition, Dr. Melaina discussed the contents of a report entitled *Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues*. He described the process of blending hydrogen into a natural gas pipeline system and noted the benefits. He also discussed the report's findings on safety, material durability and integrity management, leakage, and downstream extraction as related to blending hydrogen into natural gas pipelines, as well as proposed future work. He stated that though many issues must be

taken into consideration, blending as a means of transport (with downstream extraction) or storage is technically feasible and may be economically viable under the right conditions.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov12_3_melaina.pdf

Questions, answers, and discussion

- Dr. Ogden asked about the assumptions involved in Dr. Melaina's analysis of station cost estimates.
 - Dr. Melaina stated different station types and sizes are embedded in the equation. He added that his impression is that there is a transition from gaseous to liquid hydrogen as station capacity increases.
- Chairman Hofmeister asked about nozzle capacity.
 - Dr. Melaina responded that the nozzle details were not specified but were the same as those used in the Hydrogen Analysis Model (H2A Model).
- Dr. Ogden stated that the UC Davis costs that Dr. Melaina referenced are high because they include \$28 million in site preparation costs and should be disaggregated if the goal is to show only equipment costs.
- Mr. Koyama asked which components of capital cost are most impacted as station capacity increases.
 - Dr. Melaina stated that they did not get that information from the HSCC. They do have estimates from the H2A Model but not broken down to specifics.
- Chairman Hofmeister asked Mr. Freese to comment on whether or not the auto manufacturing industry has ramp models that predict consumer adoption patterns.
 - Mr. Freese responded that the industry submitted numbers to California estimating how original equipment manufacturers (OEMs) would increase their production volume. The analysis suggested that there would be saturation points if the infrastructure did not grow quickly enough. The ramp anticipated the price per vehicle.
- Mr. Freese asked for clarification on the purity of the hydrogen in the natural gas pipeline.
 - Dr. Melaina stated that the hydrogen is produced via electrolysis.
- Dr. Shaw asked about the maintenance requirement for appliances used to extract hydrogen from natural gas.
 - Dr. Melaina stated that clogging is not an issue, rather the orifice size must be adjusted to ensure an ability to burn. If the appliance is not maintained properly a malfunction could result.
- Mr. Novachek asked about the dynamics of injection, specifically whether or not concentrated pockets of hydrogen exist within the natural gas.
 - Dr. Melaina was unsure.
- Mr. Rose asked if regulatory prohibitions exist against injection of hydrogen into natural gas pipelines.
 - Dr. Melaina responded that it is his interpretation that technical restrictions do exist.
- Mr. Rose asked if there was any benefit to the natural gas by injecting hydrogen, for example improvement in quality.
 - Dr. Melaina responded that this reduces the carbon and there are some cost benefits.

6. Safe and Environmentally Responsible Development [of] America's Shale Resources,

Erik Milito, Director, Upstream and Industry Operations, American Petroleum Institute

Mr. Milito discussed many issues related to natural gas drilling and availability in the United States. He noted that natural gas supply and production have significantly increased over the past

decade, and that recent developments include improvements in technology, the quadrupling of shale gas production between 2006 and 2010, an increased diversity of supply, and a growing pipeline system. He remarked that the increase in shale resources provides limited environmental impact but extensive economic benefits and referenced a Manhattan Institute study that examined the economic benefits of the Marcellus shale well. He reviewed keys to exploration success, highlighting the need to manage risks effectively. Mr. Milito also discussed the roles of federal laws and regulations, state laws, and American Petroleum Institute (API) guidance and standards in the natural gas production process. He stated that API has more than 4,000 pages of standards applicable to hydraulic fracturing, and he highlighted API guidance and standards related to well construction, zonal isolation, practices for mitigating surface impacts associated with hydraulic fracturing, water management associated with hydraulic fracturing, and community engagement.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov12_4_milito.pdf

Questions, answers, and discussion

- Chairman Hofmeister asked Mr. Milito to elaborate on the environmental impacts of shale gas extraction.
 - Mr. Milito stated that most impacts are related to the surface environment and local infrastructure such as development of roads.
 - A spectator asked if the industry had examined fugitive emissions of natural gas.
 - Mr. Milito stated that the industry is continuing to examine this issue and groups such as the Environmental Defense Fund are also studying the effects of leakage.
 - Dr. Shaw cautioned Mr. Milito on the bias of the Manhattan Institute study. He added that while the economic benefits are distributed across the general population, the negative impacts from drilling are concentrated locally and can be overwhelming.
- Chairman Hofmeister asked if the regulations published by API are mandatory.
 - Mr. Milito responded that they are designed to be adopted voluntarily unless local regulatory bodies make them mandatory.
- Dr. Shaw asked if the industry is considering doing its own monitoring.
 - Mr. Milito responded in the affirmative but uncertainty remains over what role industry should take.
- Mr. Novachek asked about the lifespan of a hydraulic fracturing well.
 - Mr. Milito stated that it depends on the formation and productivity of the well. However, refracturing rates are generally declining. The initial fracturing work is no more than one week long.
- Dr. Thompson asked Mr. Milito to elaborate on the contamination potential of hydraulic fracturing on groundwater.
 - Mr. Milito stated that contamination or pollution of groundwater or the environment has never resulted from hydraulic fracturing. However, there have been instances in which surface operations such as holding ponds and well casings have failed.
- Mr. Freese asked if the well needs to be maintained after the fracture is complete.
 - Mr. Milito stated that after production has ceased, the well is plugged and land reclaimed.
- Mr. Freese asked if radioactive material is ever extracted.
 - Mr. Milito stated that the radioactive material is generally lower than background levels and is regulated by state and federal statutes.
- Dr. Lipman asked about the impact of complying with the Safe Drinking Water Act (SDWA).
 - Mr. Milito responded that the SDWA is not designed for drilling operation and would discourage drilling operations and result in job loss.

- Dr. Ogden asked if the API has ever published case studies of the problems resulting from drilling or if accident logs exist.
 - Mr. Milito stated that incidents are rare and he is unaware of any case studies or incidence database.

7. Hydrogen Enabling Renewables Working Group Updates, Frank Novachek, HTAC Subcommittee Lead

Mr. Novachek presented on the purpose, initial focus area, results of two energy storage modeling efforts, recommendations, and next steps of the Hydrogen Enabling Renewables Working Group. He detailed the conclusions of the Working Group’s “Simple Model,” noting that hydrogen is competitive in scenarios where large amounts of otherwise “spilled” energy from renewables must be captured and fast ramping is desired in addition to the energy. He also described the conclusions of the Group’s other model, the “Community Energy Model,” which included the surprisingly good match between building load, photovoltaic system peak capacity, and number of vehicles served. Mr. Novachek shared the Working Group’s recommendations for energy storage and community energy storage/transportation systems. He then stated that the Working Group’s next steps are to (1) publish a white paper with the energy storage “Simple Model” results and Working Group recommendations to the U.S. Department of Energy for further research and development, and (2) begin exploring energy storage in gas pipelines and the use of hydrogen for heat.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov12_5_novachek.pdf/

Questions, answers, and discussion

- It was decided by Committee consensus that Dr. Darlene Steward and Dr. Sandy Thomas will submit their analyses in the form of white papers. Mr. Novachek will then write an overview with the key conclusions and recommendations. All three documents will be submitted as a package to Chairman Hofmeister, who will determine whether or not to submit it to the Secretary of Energy as an HTAC product.

7.1 Comparison of Electrical Energy Storage Options, Dr. C.E. (Sandy) Thomas, Clean Energy Consultant, Clean Car Options

Dr. Thomas presented a comparison of electrical energy storage options. He first explained why intermittent renewable electricity sources require storage at times. He then reviewed electrical energy storage options, including pumped hydro, batteries, compressed air energy storage, and hydrogen storage, with a focus on cost, storage volume required, and storage potential. He discussed the financial aspects of future advanced solid oxide fuel cell systems. Dr. Thomas concluded that energy storage may be needed to enable significant renewable electricity market penetration, and that storage will be required to avoid the negative environmental impact of natural gas or coal “firming” of intermittent renewables. He also concluded that for one day of storage, hydrogen is economical at 9.1–12.4 cents/kilowatt hour (kWh); for two month’s storage, even near-term hydrogen storage is three times less expensive than the next lowest option; and for six month’s storage, hydrogen is the only viable option, at 11.1–14.3 cents/kWh.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_nov12_7_thomas.pdf

Questions, answers, and discussion

- Dr. Ogden asked if Dr. Thomas examined the benefits of shorter periods of storage.
 - Dr. Thomas had not analyzed shorter period of storage.
- Chairman Hofmeister asked Mr. Novachek if utility companies are open to advanced storage technologies.
 - Mr. Novachek stated that the utility industry is interested in any technology that lowers rates.
- Mr. Rose asked Dr. Thomas for further details on the seasonal storage system.
 - Dr. Thomas stated that the system is a 25 megawatt solid oxide fuel cell with an underground (cavern) hydrogen storage system capable of storing 39 million megawatt hours of hydrogen energy.
- Dr. Thompson asked if leakage losses were considered in the seasonal storage models.
 - Dr. Thomas responded that he did not examine leakage as there are very few leakage problems with salt caverns and other forms of ground storage

7.2 Community Energy: Analysis of Integrated Distributed Energy Systems for Power and Transportation, Dr. Darlene Steward, Senior Engineer, Deployment and Market Transformation Directorate, National Renewable Energy Laboratory

Dr. Steward presented on the potential benefits of integrating renewable electricity generation with transportation fueling. She described a grid-independent renewable energy vehicle fueling system, a renewable energy hydrogen vehicle fueling system, and a renewable energy electric vehicle fueling system. She also reviewed a representative commercial building's photovoltaic (PV) source and vehicle load, remarking that hydrogen (or electricity to battery) is produced when the PV system output exceeds the building load. She noted that the hydrogen system is about double the cost of a battery system. Dr. Steward discussed the costs of hydrogen system components and concluded that this analysis does not present a very compelling case for community-scale hydrogen fueling, although the system does allow for a fully renewable fueling scenario, among other characteristics. Her recommendations for future work included performing sensitivity analysis to determine what hydrogen system component costs would have to be in order to be competitive with battery systems and exploring more realistic scenarios for dealing with seasonal variations in PV output.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_nov12_6_steward.pdf

Questions, answers, and discussion

- Dr. Ogden asked if Dr. Steward estimated the capital cost of the system per vehicle served.
 - Dr. Steward did not. There was discussion regarding the comparative advantages of hydrogen fuel cell vehicles over battery electric vehicles. Dr. Steward stated that the main advantage of hydrogen vehicles is their substantially greater range.

8. Northeast Hydrogen Infrastructure Development Initiative, Matt Fronk, Independent Consultant, Matt Fronk & Associates and Joel Rinebold, Connecticut Center for Advanced Technology

Mr. Fronk and Mr. Rinebold described the goals, activities, stakeholders, outcomes, and needs of the Northeast Hydrogen Infrastructure Development Initiative. Mr. Rinebold noted that the DOE is supporting the Initiative through technical support provided by NREL. He shared graphics illustrating Phases 1–3 of the Initiative’s infrastructure development plan, as well as which states have adopted California motor vehicle standards. He also discussed global advances in hydrogen infrastructure development. Mr. Rinebold explained that the Initiative conducts modeling and analysis, planning, and industry coordination activities. He also mentioned that the Initiative intends to support regional deployment of fuel cell electric vehicle and hydrogen infrastructure, reduce the import and use of foreign oil, increase the use of domestic fuel, and foster technical innovation and economic development. Mr. Fronk added that the Initiative needs federal guidance, administrative and technical support, and state engagement.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov12_8_fronk.pdf

Questions, answers, and discussion

- Chairman Hofmeister suggested the Initiative engage downstream retail support as soon as fueling station locations are identified.

9. HTAC 2012 Annual Report Update, Joan Ogden, HTAC member, Annual Report Lead

Dr. Ogden described the development process and content of the HTAC 2012 Annual Report. She explained the proposed schedule and outline for the report, then solicited input from the Committee, asking for noteworthy hydrogen-related stories (e.g., events, technology results, new policy initiatives, key reports) to include in the report. She presented a list of hydrogen stories to guide committee members in identifying other stories. Dr. Ogden also asked for volunteers to assist with the report.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov12_9_ogden.pdf

The following is a list of volunteer writing assignments:

- Chairman Hofmeister: international competitiveness
- Dr. Shaw: financial issues
- Mr. Taylor: material handling
- Mr. Koyama: backup and remote power
- Mr. Triompo: fuel cell buses, stationary power
- Dr. Lipman: green hydrogen
- Mr. Freese: cars
- Mr. Rose and Mr. Eggert: regulations, codes and standards
- Mr. Novachek: energy storage
- Dr. Bond will review the complete document.

DAY 2 – NOVEMBER 16, 2012

10. Hydrogen Infrastructure Sub-Committee Report, Dr. Kathleen Taylor, Retired, General Motors

Dr. Taylor discussed perspectives on the best way to deploy hydrogen infrastructure as outlined in the report produced by the HTAC's Hydrogen Infrastructure Subcommittee entitled *Accelerating the Hydrogen Infrastructure*. The report addresses five key topic areas, including: 1) infrastructure activities targeted to automotive programs, 2) current non-automotive hydrogen/fuel cell infrastructure initiatives, 3) international infrastructure developments, 4) safety, codes, standards, regulations, and permitting, and 5) hydrogen infrastructure for industrial hydrogen. The Subcommittee's recommendations, as outlined in the report, are as follows:

- DOE needs to support the initiatives in California, Hawaii, New York, and other states from a regional perspective and use these experiences to develop a national rollout plan.
- The United States government needs to publicly and emphatically state its support for the global FCEV initiative and work closely with leading countries (Germany, Japan, Korea, UK, etc.) to develop credible and consistent rollout plans.
- These efforts need to be integrated with a well thought-out strategy to support both 2016 and 2025 CAFE mileage standards recognizing that BEVs, biofuels, and hybrids will not alone address the requirements. The hydrogen fueling infrastructure build-out should be part of a comprehensive National Energy Policy.
- The Nation should continue a strong commitment to R&D initiatives to ensure U.S. technology leadership and to build on the current knowledge base.

Dr. Taylor also recapped the main points of a webinar conducted by Catherine Dunwoody from the California Fuel Cell Partnership. She mentioned that Ms. Dunwoody noted that automakers are preparing to bring FCEVs to market in California by 2015 as an integral part of their electric drive portfolio, and that the biggest obstacle is the lack of fueling stations. Dr. Taylor stated that in this early stage, vehicles must be developed before fueling infrastructure because vehicle systems determine station configuration. She remarked that once the auto companies are committed to commercializing the vehicles, the infrastructure must grow. She referenced Dr. Joan Ogden's work on defining the necessary characteristics of fueling stations and developing plans for successful infrastructure deployment.

>>see draft report at http://www.hydrogen.energy.gov/pdfs/htac_nov12_10_taylor.pdf

Questions, answers, and discussion

- Dr. Bond commented that the introduction of the report calls for an urgent need to move forward with infrastructure and yet there is nothing in the document to support the urgency.
- Dr. Satyapal agreed with Dr. Taylor's proposal that the HTAC receive periodic updates on infrastructure deployment.

- Several members noted that the report does not include some recent developments. Mr. Rose offered to provide fourth-quarter 2012 updates to the report and send revisions to Dr. Taylor. The Committee noted that this subject area is a moving target, and agreed that once Mr. Rose's revisions and additions are incorporated, the report will be considered final. A final draft of the report will be circulated to Committee members by December 15. Brief updates can then be published as needed. The HTAC agreed that the Hydrogen Infrastructure Working Group will publish the final report as soon as possible and send it to DOE leadership. The Working Group will then disband.

11. Advancing Technology for America's Transportation Future: A National Petroleum Council Study, Dr. Anthony Boccanfuso, Director, Research and Economic Development, University of South Carolina, and Mr. Puneet Verma, Manager, Technology Ventures, Chevron

Dr. Boccanfuso and Mr. Verma presented on a National Petroleum Council (NPC) report entitled *Advancing Technology for America's Transportation Future*. The report was prepared in response to a request from U.S. Department of Energy Secretary Steven Chu for the NPC to examine opportunities to accelerate future prospects for transportation fuels through 2050, with regard to fuel demand, supply, infrastructure, and technology. The report committee was asked to consider economic competitiveness, energy security, and environment, and to make recommendations on actions that could stimulate the technical advances and market conditions needed to reduce greenhouse gas emissions in the U.S. transportation sector by 50%. The presenters explained the study approach and described the technology assessment methodology, which relied only on publicly accessible data. They detailed the 12 top-priority technology hurdles identified in the study as necessary to overcome in order to achieve wide-scale commercialization of advanced-fuel-vehicle systems by 2050. They also discussed study findings related to fuel economy, greenhouse gas (GHG) emissions, and infrastructure including their conclusion that compared to today's conventional light duty vehicles, GHG emissions can be reduced 50% on a well-to-wheels basis through the deployment of FCEV fueled by hydrogen from natural gas. They also listed several vehicle technology hurdles that must be overcome for wide-scale commercialization of advanced fuel vehicle systems by 2050, including vehicle lightweighting, increasing of lithium-ion battery energy density and longevity, and combustion optimization. Dr. Boccanfuso and Mr. Verma then shared additional insights from the study, discussed the technology readiness of FCEVs and hydrogen fueling infrastructure, summarized the benefits and challenges of hydrogen, and described the overall study recommendations.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov12_11_boccanfuso.pdf

Questions, answers, and discussion

- Chairman Hofmeister suggested examining mass transit, integrating renewables into the grid, and renewable hydrogen as strategies for further reducing GHG emissions in the transportation sector.
- Dr. Ogden asked if renewable biofuels were considered as part of the strategy to reduce GHG emissions.

- Mr. Verma responded that the data includes all available technologies, including advanced fuels.
- Dr. Shaw and Mr. Verma compared the NPC study to a similar study released by the National Academy of Science (NAS). Dr. Shaw stated that the NAS study assumes a fairly aggressive ramp-up and they were able to reduce GHG emissions to close to zero in light-weight vehicles by assuming a significant hydrogen use.
 - Mr. Verma noted that centralized steam methane reforming of natural gas was the assumed hydrogen production method. The report did not include much renewable hydrogen. All technologies were competed on an economic basis.
- Dr. Ogden asked if the NPC study examined carbon capture and sequestration (CCS).
 - Mr. Verma stated that CCS was considered but not ultimately incorporated into any of the pathways.
- Dr. Boccanfuso stated that the NPC's model is online and available to anyone. Users may input different numbers than the NPC used. All data is publically available.
- Mr. Rose asked about the gasoline price assumptions.
 - Mr. Verma responded that the petroleum prices, as well as the electric grid mix, are derived from the Energy Information Agency's (EIA's) *Annual Energy Outlook* 2010.
- Mr. Lipman asked if any of the scenarios in the model were able to reach 50% GHG reductions.
 - Mr. Verma stated that of the 23,000 scenarios, only a small number were able to reach 50% GHG reductions. He noted that these scenarios included a combination of low-probability, "extreme" assumptions, such as oil prices at more than \$200/barrel, high use of advanced biofuels, consumers adopting 17-year economics for vehicles, limited availability of natural gas vehicles, etc. He noted that most of the scenarios that *did* meet the 50% reduction included FCEVs.
- Mr. Chalk asked if the model was applicable to the United States or worldwide.
 - Mr. Verma stated that the model was based in the United States.
- Mr. Chalk asked about the assumptions for vehicle miles traveled over time.
 - Mr. Verma did not remember the exact number.
 - Dr. Boccanfuso added that they did not examine consumer preference issues, demographic changes, or disruptive trends. He reiterated that the study used only publicly available data.
- Dr. Shaw asked if any policy drivers such as carbon taxes were taken into consideration.
 - Mr. Verma responded that no new policies, including tax on carbon, were considered. Like the EIA, the NPC assumed today's policies into the future.
- Dr. Ogden asked about the assumption of numbers of hydrogen stations.
 - Mr. Verma replied that the report assumes that hydrogen is supplied at one-third of the fueling stations across the U.S., since this is the point at which the EIA says there is not a fueling anxiety problem for the consumer. In response to questions about the hydrogen station cost, Mr. Verma noted that the report does include a per-station, and a per-car cost, and noted that their costs include all of the infrastructure needed for each hydrogen station (including truck or pipeline hydrogen delivery, etc.).
- Mr. Chalk asked for clarification on vehicle range, particularly on why the report does not identify compressed natural gas vehicle range as a problem.
 - Mr. Verma stated that on the vehicle side, everything other than battery electric vehicles was normalized around a minimum 300 mile range. The natural gas vehicle (NGV) experts on the NPC committee contended that an NGV could be engineered to achieve a 300mile range.
- Mr. Chalk responded that this assumption is a stretch, given the fuel economy of an NGV.
- Dr. Shaw asked about the study's automotive fuel cell durability assumptions.

- Mr. Verma stated that they used NREL’s evaluation of 2,500 hours, since this was the best-available published data.
- Dr. Shaw responded that this number is way low for today’s technology, since the NREL data is based on testing of early-generation FCEVs.
- Mr. Verma noted that the report does address this issue in the text.
- Dr. Satyapal asked if there was an equivalent chart for durability in the battery chapter.
 - Mr. Verma replied that they tried to find a public source for the data, but could not, so they did not include durability data for batteries, but they did note in the report that it is unknown.
 - Dr. Satyapal suggested that the NPC could have used the Idaho National Laboratory’s electric vehicle technology validation database.
 - Mr. Chalk noted that data are necessary to back up assertions about technology performance, and if the data are not available it should be clearly noted as a gap. He pointed out that this is a messaging problem, since the report shows a fuel cell durability graph that indicates fuel cells fall about 50% short of where they need to be, but there is not a parallel conclusion for batteries.
 - Mr. Verma noted that there was a large amount of public data available on hydrogen and fuel cell technologies; this was not the case for many of the other pathways.
- Chairman Hofmeister stated that it is important to keep in mind that the public is of the impression that both hydrogen and electric vehicles are a long way from commercial readiness.
- Mr. Koyama expressed concern over classifying battery electric vehicles and biogas and natural gas fueled vehicles as alternative when they are already in commercial operation.
 - Mr. Chalk responded that although these technologies are commercial they may not be as durable as internal combustion engine vehicles.
- Dr. Ogden asked Mr. Verma to elaborate on the costs associated with on-site compression at fueling stations.
 - Mr. Verma stated that the issues are not with technology, but rather real estate availability as well as cost. They felt compressor reliability issues could be overcome, however at a high cost.
- Dr. Shaw expressed concern that the range of the FCEV was assumed to be only 300 miles.
 - Mr. Verma stated that this was defined as the minimum range, not the maximum.
- Mr. Chalk asked if the NPC study was influenced by the DOE’s Quadrennial Technology Review (QTR).
 - Mr. Verma stated that the NPC study and DOE QTR were being conducted at the same time. He noted that several of the DOE representatives to the NPC committee were also involved in work on the QTR, but the QTR did not directly influence the NPC study.
- Chairman Hofmeister asked if there were plans to submit this study to Congress or other policy-making centers.
 - Dr. Boccanfuso stated that members of the study’s team have been aggressively presenting their findings to a variety of forums. They have participated in a briefing at the White House involving staff of the Senate Energy and Water Development Committee as well as the Center for Strategic International Studies.

12. Deputy Assistant Secretary for Renewable Energy Mr. Steven Chalk, Energy Efficiency and Renewable Energy, U.S. Department of Energy

Chairman Hofmeister invited Mr. Chalk to give a few remarks to the Committee. Mr. Chalk noted that historically, EERE’s top priority has been technology cost reduction. As technologies

are maturing, EERE now defines its priorities more broadly, to include priorities targeted towards overcoming deployment barriers. This includes infrastructure, manufacturing, grid integration of renewables, institutional barriers, and so forth. EERE has a role in doing analysis to inform good policy and developing data to show the business case. Mr. Chalk stated there is an urgent need to develop viable strategies for the transition to hydrogen and fuel cell commercialization, including fueling infrastructure deployment; and he invited the Committee to make recommendations. He also welcomed the Committee's suggestions on any technology areas that may have been under-represented in the R&D portfolio, such as forecourt technology and hydrogen compression.

Questions, answers, and discussion

- In response to a comment from Dr. Rose about DOE's role, Mr. Chalk noted that there are limited funds for EERE to invest in a lot of hardware and infrastructure -- its main role in technology development is precompetitive R&D. He stressed a need to focus limited early infrastructure investments on a few areas or clusters, like California, so that the probability of success is higher.
 - Dr. Shaw suggested that at least one hydrogen infrastructure investment be made on the East Coast, to represent the technology on a more national level.

13. Chairman's Open Discussion

Chairman Hofmeister led an open discussion with the Committee. He explained that he has held individual conversations with a number of the Committee members to get feedback on the HTAC's operations and products. He described the highlights of these discussions, and divided the feedback into four general focus areas, as follows.

- 1) **HTAC Governance.** In the area of Committee governance, the Working Groups have been effective, but there is a question about how many degrees of freedom they have and if there is funding from DOE to support their meetings or analysis activities. In general, Working Groups should be established to focus on a specific product or outcome, and then be disbanded. Mr. Hofmeister questioned the role of the HTAC Policy and Planning Subcommittee (PPC). He proposed disbanding the PPC because its subject matter should be addressed by the Committee as a whole rather than just a sub-group. [The HTAC later agreed to disband the PPC Subcommittee.]
- 2) **HTAC Profile.** There is strong interest in raising the profile of HTAC within the DOE and in the external community. There is interest in maintaining closer ties with DOE management (e.g., increasing face-to-face meetings or conference calls with DOE management).
- 3) **HTAC Resources.** Chairman Hofmeister also noted that HTAC members are concerned about resources. Members are concerned that the Committee will be "starved out of consideration," and questioned whether there is a role for HTAC in providing input to budget priorities, given the Committee's position as a Congressionally authorized body. That is, could the Committee provide input on how it could support the DOE and its support needs?

In this regard, Committee members strongly support a minimum of two face-to-face HTAC meetings per year.

- 4) **HTAC Outcomes.** Members are interested in defining a process for establishing outcomes or products that we, as a Committee, would like to see or produce. This could include things like a scorecard for the hydrogen and fuel cell economy, a scorecard for the impact of HTAC and how well the Committee is functioning, special topics that we'd like to consider and make recommendations on as a group, establishing annual objectives and milestones, establishing an initiation and closure process, etc. There is also an issue surrounding the scope of our purview—that is, where does “technical” begin and end? Is it with technology research, or development, or demonstration, or implementation, or at another stage? His conclusion after speaking with members was that a broader definition of *scope* would better support HTAC'S impact and outcomes.

Questions, answers, and discussion

- Mr. Chalk stated that the HTAC helps keep the DOE relevant to industry by directing focus to areas that the private sector considers in need of resources. He added that analysis or studies to inform policy and issues of financing all fall within the purview of the Committee.
- Dr. Shaw stated that the PPC was first formed to help the HTAC develop the meeting agendas, plan discussion topics, and suggest products such as the Annual Report.
 - Chairman Hofmeister stated that the Committee as a whole has matured and is no longer in need of the PPC as planning and reports are done collectively. He asked interested HTAC members to submit ideas for agenda topics or priority discussion areas. He will support the current process of working with the Vice Chairman and the Committee members to develop the HTAC meeting agendas.
- Chairman Hofmeister asked whether the HTAC is required to deliver a report to DOE every two years.
 - Dr. Satyapal clarified that DOE is required by statute to deliver a report to Congress every two years which responds to HTAC's recommendations to DOE. She suggested that HTAC include its recommendations in its cover letter to the Secretary transmitting their Annual Report.
- Dr. Bond pointed out that in other Committees he has served on, they have been asked by DOE to give advice on particular subject matters. He believes this would be a more effective way to gain the interest and engagement of upper DOE management. Chairmen Hofmeister and Dr. Shaw discussed the importance of requesting a meeting with Secretary Chu.
- Mr. Novachek clarified that his proposed idea for an HTAC “score card” would measure progress on the particular areas in HTAC's charter on which it is supposed to advise and comment, rather than evaluate how the HTAC is functioning.
- Mr. Rose stated that a self-evaluation of the HTAC would also be beneficial, perhaps through a member survey. With regard to the matter of HTAC resources, one of his priorities would be to preserve the face-to-face meetings, and have at least two per year. He suggested that there might be ways to reduce the burden on DOE's budget, for example by having HTAC

- members organize and host meetings at their locations. Mr. Koyama suggested an annual process to develop an agenda for the year, with outcome targets to guide the year's meetings.
- Chairman Hofmeister stated that he would write a letter to the HTAC members summarizing the feedback he has received so far, and elicit feedback on what the Committee should do over the next 2-3 years and how it should do it. He suggested that a discussion on this topic be included in the next HTAC meeting agenda.
 - Dr. Satyapal said that as an advisory committee, the HTAC has produced a lot of valuable recommendations to the FCT Program, many of which have been incorporated into program plans. Examples include the HTAC's help and advice on revising the Program's cost target, and organizing and holding the Hydrogen Production Expert Panel workshop (which was attended by Secretary Chu). The Program has also benefited from the technical experts on the Committee as well as those that have presented as guests at meetings. She stated that the HTAC has always been especially helpful when the Program has asked for specific advice, for example with the H-Prize. She urged the HTAC to consider the five questions posed by Dr. Danielson in his remarks to the HTAC during the November 15 meeting. He mentioned that manufacturing competitiveness is a particularly important focus area for the Administration, and the EERE Advanced Manufacturing Office will be setting up manufacturing demonstration facilities. HTAC'S input on what government can do to help enable manufacturing competitiveness for hydrogen and fuel cell technologies would be very useful. She added that the focus of the manufacturing demonstrations will be crosscutting areas that could have an impact on many industries, such as machining, or molding.
 - Dr. Shaw urged the Committee to continue inviting small- and medium-sized entrepreneurs to present at meetings.

14. Overview of Hydrogen Systems Analysis Research at UC Davis, Dr. Michael Nicholas, Postdoctoral Scholar, Institute of Transportation Studies, University of California, Davis
Dr. Nicholas detailed the University of California, Davis' (UCD's) past, current and future hydrogen systems analysis research. Dr. Nicholas noted that UCD's Sustainable Energy Transportation Pathways (STEPS and NextSTEPS) research projects, which started in 2011 and will continue until 2014, focus on integrative scenarios and transition strategies built on transition dynamics, models, and policy analysis. He highlighted several research projects ranging from a study of hydrogen households to infrastructure rollout strategies and the implications natural gas on hydrogen production. Dr. Nicholas presented in detail on a project that found that a regional scope for infrastructure rollout enables aggregated demand and lower infrastructure costs. Dr. Nicholas also discussed UCD's analysis of rollout strategies for FCEVs and hydrogen infrastructure in California, with a focus on the Los Angeles Basin. He described different manifestations of the cluster strategy and noted that demand for hydrogen vehicles is strongly influenced by hydrogen station location. Dr. Nicholas shared numerous conclusions from his analysis, including that a sparse initial network of 8–20 small stations would suffice until the number of vehicles in the region reaches the tens of thousands, at which time adding larger stations would offer scale economies and lower hydrogen costs.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_nov12_12_nicholas.pdf

Questions, answers, and discussion

- Mr. Rose and Mr. Koyama asked for clarification on the assumptions about number of vehicles supported within each cluster described by Dr. Nicholas.
 - Dr. Nicholas stated that the clusters are based on assumptions of customer density rather than the number of vehicles supported.
- Dr. Shaw asked if Dr. Nicholas conducted interviews or focus groups to understand the vehicle purchasing decisions and driving habits of someone located in a cluster area.
 - Dr. Nicholas stated that they did not do formal focus groups or interviews, but he had talked to some people about their purchasing decisions and driving habits.
- Dr. Steward asked if the analysis examined non-individual vehicle purchasers, for example rental car agencies.
 - Dr. Nicholas agreed that this would be a good idea, but the analysis does not currently consider that.
- Chairman Hofmeister asked if Dr. Nicholas had spoken with station owners.
 - Dr. Nicholas stated that they did consult with a representative of a station owner association.
- Dr. Shaw asked Dr. Nicholas to comment on the California Fuel Cell Partnership's belief that 68 hydrogen fueling stations are necessary in Southern California to serve the expected vehicle fleet.
 - Dr. Nicholas responded that he believes 68 to be an accurate capacity number and discussion should focus on the distribution of the stations.
- Dr. Thompson asked about new-car purchasing trends.
 - Dr. Nicholas stated that the number fluctuates but averages about 1.1 million new cars purchased per year in California.
- Dr. Melaina (NREL speaker from the first day of the meeting) speculated that station patronization would increase if they were located between neighborhoods and commuting destinations, creating a basin effect.
 - Dr. Nicholas agreed, stating that there are natural collection points. The UCD team plans to look at this in further analysis.
- Chairman Hofmeister cautioned that local county attorneys should be briefed before building a new hydrogen fueling station because of the litigious potential associated with new technology.
- Mr. Taylor pointed out that the profit (or loss) margins of **both** station owners and the industrial gas suppliers will be affected by setbacks in hydrogen demand or delays in station construction.
- Dr. Shaw asked if any excess hydrogen is produced from the steam methane refineries in the Los Angeles Basin. He also asked Mr. Taylor if he would expect an industrial gas producer to brand the hydrogen it sells.
 - Mr. Taylor stated that some excess hydrogen is produced but it was not at the 300+ bar pressure that a FCV application requires. An investment in compression and distribution equipment would be necessary to deploy this excess hydrogen. He said that the industrial gas companies would sell the molecules – the brand name of the fuel would be given by

the energy company or station owner. However, if the gas company sells the dispenser, they would likely include their company logo on it somewhere.

- Dr. Shaw asked if Dr. Nicholas examined lessons learned from the material build-out of the gasoline fueling infrastructure, e.g., what the costs were and how they were borne.
 - Dr. Nicholas pointed out that Dr. Melaina wrote a paper on this topic, and Dr. Melaina agreed to email his study to Dr. Shaw.
- Dr. Taylor commented that it is important for a purchaser of an FCEV to have a guarantee that the number of fueling stations in an area will not decrease over the lifetime of the vehicle.
 - Dr. Nicholas stated that vehicle leasing may help alleviate some of that concern.

15. HTAC Business

- A teleconference will be scheduled in February to review the draft HTAC Annual Report.
- The next in-person HTAC meeting will take place April 23-24, 2013 at the NREL offices in Washington, DC.
- Chairman Hofmeister proposed a teleconference for those interested in discussing strategies for financing and economically operating the first wave of hydrogen stations. He suggested they target the week of December 17.
- Chairman Hofmeister proposed requesting a teleconference with Dr. Danielson to discuss how an early hydrogen station business case could fit in with new DOE Transportation Sector strategies and activities.
- Potential topics for upcoming meetings:
 - Business strategies for infrastructure development, including analysts from the California Fuel Cell Partnership, NREL, and international organizations as well as station owners.
 - Mr. Rose suggested a webinar on this topic be held before the April meeting.
 - Dr. Thompson suggested presentations from venture capitalists areas other than alternative energy, for example information technology.
 - Discussion of HTAC operations, discussion topics, and outcome targets (as follow-up to the November 16 Chairman's Discussion).

Meeting Adjourned

NINETEENTH MEETING OF THE

HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE (HTAC)

PARTICIPANT LIST

November 15-16, 2012

HTAC Members Present

- Peter Bond
- Gary Flood (via conference line)
- Charles Freese
- John Hofmeister
- Maurice Kaya (via conference line)
- Harol Koyama
- Tim Lipman
- Frank Novachek
- Joan Ogden
- Robert Rose
- Robert Shaw
- David Taylor
- Kathleen Taylor
- Levi Thompson
- Joe Triompo
- Bill Wylam

HTAC Members Not Present

- Mark Cardillo
- Richard Carlin
- Anthony Eggert
- Alan Lloyd
- Geraldine Richmond
- Jan van Dokkum

U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Staff

- Channing Ahn
- Steve Chalk
- David Danielson
- Peter Devlin
- Rick Farmer
- Nancy Garland
- Hai Hugh Ho
- Fred Joseck
- Jason Marcinkoski
- Eric Miller

- Sunita Satyapal
- Joseph Stanford
- Erika Sutherland

Members of the Public in Attendance

- Anthony Buccanfus—University of South Carolina (presenter)
- Matt Fronk—Matt Fronk & Assoc., LLC (presenter, via conference line)
- Leo Grassilli—Office of Naval Research
- James Kliesch—American Honda Motor Co.
- Bill MacLeod—Cascade Associates
- Morry Markowitz—Fuel Cell and Hydrogen Energy Association
- Marc Melaina—National Renewable Energy Laboratory (presenter)
- Erik Milito—American Petroleum Institute
- Michael Nicholas—University of California Davis
- Pinakin Patel—FuelCell Energy, Inc.
- Joel Rinebold, CCAT (presenter, via conference line)
- Dan Ryan—Mazda North America
- Robert Sale—International Code Council
- Jeff Serfass—California Hydrogen Business Council
- Darlene Steward—National Renewable Energy Laboratory (presenter)
- Sandy Thomas—Clean Energy Consultant (presenter)
- Puneet Verma—Chevron Technology Ventures (presenter)
- Emanuel Wagner—California Hydrogen Business Council
- Steven Weiner—Pacific Northwest National Laboratory

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- Shawna McQueen—Energetics Incorporated
- Lilia Murphy—Alliance Technical Services, Inc.
- Neil Snyder—National Renewable Energy Laboratory
- Tom Timbario—Alliance Technical Services, Inc.