HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE

MEETING MINUTES -- DRAFT

November 6-7, 2008

Washington Marriott, Washington, DC

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November 6, 2008

1. *Call to Order, Agenda Review*

The meeting of the Hydrogen Technical Advisory Committee (HTAC or Committee) was called to order at 9:00 am by newly elected Chairman Walker and Vice-Chairman Shaw. Several new members to the committee were introduced:

- Mr. Maurice Kaya
- Mr. Frank Novachek
- Dr. Ken Schultz

Biographical information for all current members can be found at http://www.hydrogen.energy.gov/advisory_htac.html.

2. *New Member Orientation and Expiring Member Recognition Process*

Ms. Epping-Martin asked the Committee for input on how to orient new HTAC members and how to recognize past members. Due to the often last minute nature of appointments, Ms. Epping-Martin asked HTAC to comment on DOE's draft process to brief members before their official appointments (See HTAC Briefing Book: Tab 2). HTAC largely agreed to the plan laid out by DOE in the briefing book. HTAC made the following additional comments:

- Dr. Shaw asked Ms. Epping-Martin to put together a list of current and former HTAC members which includes their dates served, current addresses, and email. Ms. Epping-Martin agreed and suggested the non-personal information could be made available on the public portion of the HTAC website and the full information could be made available to members.
- Chairman Walker suggested he and Past Chairman Lloyd send a note to the former members to thank them for their service. He thought this should become common practice. Ms. Epping-Martin added that the Secretary also sends a thank you note to past members.
- EPAct 2005, which established HTAC, called for one-, two-, and three-year terms. After the first year of HTAC's operation, only three people were rotated off; since then, a larger number have departed each year to allow for new members. DOE tries to talk with members about whether they would like to continue their service when looking for people to rotate off. They also try to keep balance on the committee.

3. *Briefing on H-Prize*

Mr. Jeff Serfass, Hydrogen Education Foundation

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_nov08.html

Mr. Serfass briefed the Committee on the status of the HPrize. Hydrogen storage has been selected as the topic for the initial $1 million prize and efforts to establish parameters for that prize are underway. He asked for advice on a number of areas and will potentially revisit the Committee for future guidance.

The topics covered by the presentation included:

- The selection of the Hydrogen Education Foundation, the philanthropic arm of the National Hydrogen Association (NHA), as the prize administrator
- The Hydrogen Education Foundation's key administrative objectives
- Technology challenges potentially addressed by the H-Prize
- Determination of a hydrogen storage prize as the first award to be announced (target award date is at the Hydrogen Annual Merit Review in May 2010)
- Fundraising plans for future prizes, in areas like fuel cells or complete demonstration systems
- Procedure for selection of technical criteria and judging
- Current status of hydrogen storage efforts
- Potential areas for HTAC involvement, including advice on evaluation criteria; potential sponsors and judges; and other input

Proposed Prizes:

- \$1 million for hydrogen storage (initial prize)
- Advancements in technologies, components and systems (≤ \$1 million each)
    - Hydrogen production
    - Hydrogen distribution
    - Hydrogen utilization (fuel cells)
- ≤ \$4 million for prototypes
- ≥ \$10 million plus matching funds for transformational technologies

Questions, Answers, and Discussion

- There may be multiple \$1 million awards, but anything beyond the first \$1 million award for hydrogen storage must be paid for via fundraising from outside sources or future government allocation. DOE money will finance the first prize and seed the process, but according to Mr. Serfass the "real challenge is to leverage those funds from foundations or corporations that see the value in this to stimulate innovation." The Hydrogen Education Foundation is working with a partner, South Carolina Research Authority, who hopes to issue a fundraising plan by the end of November 2008. The efforts will include a combination of email solicitations, mail solicitations, and personal visits aimed at industry, foundations, and other government agencies. Mr. Hofmeister noted that the current economic climate will make the fundraising effort more difficult.
- The legislation is not entirely clear about who is eligible to compete for the prizes, but the prime submitter in a group must be incorporated in the United States and an individual submitter must be a U.S. citizen.
- Dr. Shaw wondered if less than two years was enough time to see progress worthy of a \$1 million prize. If the purpose of the H-Prize is to establish "huge goals" that cannot be met with existing technologies or materials, then this seems like too short of a timeframe. Dr. Satyapal agreed that the purpose of the H-Prize is to stimulate innovation and brand new approaches to challenging problems—as a complement to the DOE R&D program (not a substitute for it). She explained that the first prize is intended for something like a new material that can lead to a scientific breakthrough (not a full scale, working system). She clarified that the target date of 2010 is flexible. The prize committee will establish strict criteria (including the ability to validate and reproduce the results by a third party) and will set the bar high—a prize will be awarded only if the criteria are met.
- Dr. Shaw stressed the importance of the prize as a motivator for innovation. As such, it should be awarded to ideas or inventions created *after* the announcement of the prize, as opposed to something that is "already in the pipe somewhere." He suggested that the prize committee could define the date of the invention by using dating techniques similar to those employed by the U.S. Patent Office (e.g., notarized lab books, peer reviews. etc.).
- Mr. Eggert observed that there are different stages of research, development and engineering involved in developing new products. He wondered whether the H-Prize awards could be phased, with down-selections at each stage, and an ultimate grand prize winner. Dr. Satyapal replied that the H-Prize could be structured this way if the administering entity chooses to do so. She noted that DARPA uses a prequalification process for its awards. At a minimum, the H-Prize will include certain eligibility criteria, such as safety, as a prequalification screening tool. Mr. Serfass added that there is a desire to keep the process relatively simple in order to (1) make an award in 2010 as a way to build momentum

for fundraising for future prize, and (2) keep the overhead budget low. Both the extra time required for a prequalification round and the limited overhead budget are factors weighing against a prequalification round.

- Dr. Satyapal mentioned that the prize team had received input from the FreedomCAR and Fuel Partnership's Hydrogen Storage Technical Team on draft criteria for the storage H-Prize, but still needed feedback from the larger R&D community before the final criteria are decided upon.
- Dr. Ogden expressed support for the idea of starting with smaller prizes (even down to the level of $100,000) and building to larger prizes ($1 to $10 million) for bigger challenges and major breakthroughs that could take many years to achieve. She noted that smaller prizes could serve as big motivators for individual researchers at universities and national laboratories. This could also provide a path for awarding multiple prizes reasonably soon. Dr. Milliken agreed, adding that it could be difficult to find an achievement worthy of a $1 million award by 2010. The concern is that smaller awards could "dilute the effect" of the H-Prize, so this idea needs to be more fully considered.
- Mr. Katsaros asked whether the intention is to award the prize to an individual or an institution. He noted that a $100,000 prize, while exciting to an individual researcher, may not be exciting to a large university or corporation. Mr. Serfass responded that the award can go to either an individual or an institution (and that this will be clarified in the prize criteria). He also noted that the intention (as of now) is to make a single, $1 million award with the initial prize, so the prize is large enough to be significant.
- Mr. Eggert suggested involving the venture capital community as H-Prize judges and/or sponsors. He noted the synergies between the two groups—those who are looking for inventions to fund and those who are developing new ideas. Mr. Serfass agreed with this observation, and noted that the team will include venture capital companies in its broad-based solicitation.
- Dr. Shaw expressed his support for the H-Prize, but stressed the need for careful planning so that the prize is taken seriously. He urged that "great care be taken in putting together the first shot at this," and suggested that the HTAC be given another chance to review and comment on the prize process and criteria once they are more precisely defined. Dr. Milliken agreed with Dr. Shaw, and that, if possible, DOE will provide another draft of the prize criteria to HTAC for review.
- Dr. McCormick stressed the need for careful validation of results or a refereed approval process. He wanted to be sure the science is correct before prize money is awarded. Dr. Satyapal told the Committee that DOE has set up an independent test facility to test storage materials and is considering the use of this facility to validate materials submitted for the prize.

4. *Coordinated State and Federal Hydrogen Fuel Cell Vehicle Policy Initiatives*

Dr. Sigmund Gronich, Charisma Consulting

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_nov08.html

Dr. Gronich spoke on the need for coordinated state, Federal, and international government action to hasten the move to alternative energies and to enhance the viability of fuel cell vehicle (FCV) technologies. He supports policy initiatives that would allow hydrogen fuel cell vehicles (HFCVs) to deploy within commercial markets, with the policy help they need to survive the "valley of death."

The topics covered by the presentation included:

- The need for a global greenhouse gas (GHG) policy

- The need for balanced social policy to provide both regulation (the stick) and government cost share (the carrot)
- Letting the marketplace decide which technologies will prosper
- Recognition of HFCVs as competing with plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs), and biofuels
- Overview of the status of the California Zero Emissions Vehicle (ZEV) Mandate
- Analysis showing the stages of commercialization, fuel cell learning curve, the "valley of death," and cumulative government outlays
- Suggestions:
    - Recommend that there be an industry/government meeting to revise targets that are necessary to consider mass producing HFCVs (2009-2010) to meet the President's and California state's 2050 CO_2 reduction goals of 60 to 80%
    - Recommend to the Secretary of Energy and Presidential Transition Team that a second Learning Demonstration Program be submitted as part of DOE's 2010 budget submittal, as authorized in EPACT 2005. The second program should be extended to 2017 with HFCV numbers that are consistent with California ZEV mandate requirements during 2012-2014, and a "volume of production phase" during 2015-2017 if warranted by technological progress and industry commitment.

Questions, Answers, and Discussion

- Dr. McCormick commented that using the word "demonstration" indicates a lack of seriousness and a lower level of progress than has actually been achieved. If companies are expected to invest billions of dollars moving forward, then we need to convey the fact that this is "something more than a science experiment." He suggested finding another phrase, such as "first phase commercialization," to represent demonstration efforts. Congressman Walker agreed, and suggested "Initial Commercialization Demonstration Program" as a better term for indicating the status of technology development. Dr. Gronich agreed, but noted that governments in the United States and in Europe need to be careful about interfering with (or seeming to interfere with) markets. The main thing, he said "is that there be a program where the government can cost share 50/50 with the industry going through that phase of the 150,000-200,000 vehicles."
    - Dr. Milliken stated that the current learning demonstration is called that because it is a 50/50 cost share program aimed at validating the technology and developing data to communicate to consumers, Congress, and management on technology status. A second phase would indicate more progress and require a higher industry cost share. Dr. Gronich expressed his opinion that a 50/50 cost share level may be needed even in a second phase of demonstrations in order to ensure that the vehicles are competitively priced for consumers.
- Dr. McCormick noted that automakers will likely be wary about a second demonstration program. He noted that states and Federal agencies do not have a good track record for funding the cost shared programs that industry has already signed on to and made investments in. A second demonstration program will be more expensive, and require proportionally larger investments from industry; industry will need to be convinced of government's commitment to their part of the bargain. Dr. Gronich suggested that one way to make this happen would be for Congress to appropriate funding for the demonstration program to cover multi-year increments (e.g., three years).

- Dr. McCormick noted that when car companies or energy companies say they "may be able to do something," it is often followed in the United States by a binding mandate, which is why many companies have been reluctant to talk with government (state or Federal) about target dates for vehicle rollouts and so forth. A framework without mandates is needed to open discussion, similar to what is happening in Europe, where a target date of 2015 has been agreed upon by the energy and automobile companies. Dr. Gronich agreed and said the notion of hydrogen being an "out there" technology comes partially from the automakers being conservative in California because they do not want to commit to a mandate.
- Dr. Gronich added that the California Air Resources Board (CARB) staff have been directed by the board to "rip up the 2015 to 2017 ZEV targets" and to consider what is needed to meet the 2050 CO_2 reduction goals. The CARB is expected to make a recommendation on this in 2009 and will be coming to industry for input. Dr. Gronich believes the current mandate/goal for 25,000 ZEVs by 2015–2017 is either too many (if we are in a technology development phase) or too few (if the intent is to enter a volume production phase and begin coming down the cost curve in advance of the 2050 CO_2 reduction goals).
- Dr. Gronich suggested that the hydrogen program focus on a more positive message—that though it is four or five years behind when PHVs enter the marketplace, it is not far off and will be competitive with PHEVs.
- Dr. Milliken offered comments to support Dr. Gronich's recommendation for revision of the technical targets. She reported that the FreedomCAR and Fuel Partnership is currently revising its HFCV targets to reflect changes in technology and the energy environment. The Hydrogen Storage Technical Team has almost completed revising its targets; the Hydrogen Production, Hydrogen Delivery, and Fuel Cell Technical Teams are in progress. She noted that the European Union's Joint Technology Initiative has set a target for fuel cell cost of $75 per kilowatt (much higher than the DOE target) and that the DOE's benchmark for fuel cell cost, which is the internal combustion engine cost, is increasing because of rising fuel economy standards and emissions control requirements.
    - Dr. Gronich later emphasized the importance of revising the targets for FCVs using a baseline that is more realistic—the likely competitor for HFCVs will not be internal combustion engines, it will be something like a PHEV.
    - Dr. Ogden added that cost comparisons for HFCVs, plug-in hybrids or other advanced vehicle technologies should include costs for increasing the renewable component of the fuel and reducing GHG emissions. It will be useful to know how these costs compare to what people are used to paying now for gasoline-powered cars.
- Dr. Ogden pointed to the results from the NRC study and other studies which indicate that a diverse portfolio approach is needed to meet the nation's energy security and GHG goals. She suggested that hydrogen be described as an important component of this portfolio, which could also include plug-in hybrids, BEVs, and ethanol fuel. The government cost share required to buy down the costs of early FCVs and initial hydrogen infrastructure (which the NRC report estimated at $55 billion total through 2023) is on the same order of magnitude as subsidies for other alternative technologies (ethanol, BEVs, etc.). Dr. Ogden also noted that the NRC scenario analyses did include side cases in which less stringent cost targets were met (e.g., a fuel cell cost of $50/kW for vehicles). These cases also resulted in hydrogen becoming competitive and an important player in the vehicle market, though a few years later and at somewhat higher cost.

- Dr. Gronich emphasized that each technology must be advanced to the point where they can compete against each other, ultimately allowing the marketplace to decide how the options interact and which is the lowest cost option to achieve the goal of 60–80% CO_2 reductions. He observed that an electric vehicle platform can be designed for a large or a small battery, and this will affect costs and technology choices.
- Mr. Hofmeister advocated a firmer HTAC position on the importance of the HFCV, claiming that the nation does not have the time to allow the infrastructure to develop for five or six different vehicles to compete and decide the fate of clean transportation mobility. He pointed to what is happening in other countries, particularly in Japan where the government is not letting the market decide but is actually making some choices. Dr. Shaw agreed, reiterating that the Obama Administration must be quickly convinced about the importance of hydrogen infrastructure and the need for immediate action. He noted that the NRC study concluded that, while a portfolio approach will be needed, we cannot get to a substantial enough reduction in oil use and carbon emissions without the hydrogen option. As a venture capitalist, Dr. Shaw is a market advocate; however, he agreed that the market has been ineffective in solving this problem. He stressed that quick and decisive action is needed, and noted that the estimated costs of acting are not that high, especially considering the cost of *not* acting and the potential for reaching dangerous levels of atmospheric CO_2 emissions in the not too distant future.
- Dr. Gronich asserted that HFCVs should be placed "on the same starting line" as the other alternatives so that fair competition among the technologies can occur. He stressed that he has tried to present an approach that is aggressive, but takes into account practical limitations on the amount of time it takes to get vehicles from the design stage to the showroom. While progress on HFCVs is being made, he believes it is unrealistic to think that the industry can put more than one million HFCVs on the road in the United States prior to 2020.
- Dr. Richmond questioned whether there would (or could) be a connection between possible "bailout" loans to the automobile industry and discussions with the transition team about the future of HFCVs. She wondered whether it would be possible to "earmark" some of the bailout funds specifically for advancement of HFCVs. Dr. Gronich responded that if the intent of the bailout is to use some of the funds for building new production facilities, then this idea could certainly be part of the strategy.
- Dr. McCormick remarked that most automakers are already engaged in development and design work for HFCVs. The biggest expenses come when the companies invest capital to produce vehicles for low volume markets and have to absorb losses on vehicle sales. If the goal is getting HFCVs into vehicle showrooms by 2015, the automakers will face a decision in 2010 or 2011 on whether to make those capital investments and begin producing HFCVs in some sort of volume. Two key questions will be asked.
    - Is there a robust enough fueling infrastructure in place or planned to convince customers that this is a real and viable option for them?
    - Is the correct government support in place to balance the industry-side financial risk?
- Mr. Eggert noted that discussions in which each side simply "pitches its own case" are not as productive as those that look at synergistic opportunities, and suggested that there are synergies to explore between the various alternative vehicle technologies, for example, how PHEV technology is relevant to HFCV technology. He also commented that there are opportunities to communicate with the incoming administration as they design policies, and help to ensure that policies adequately consider the timing aspects and what will be required to meet programmatic goals. Dr. Gronich

agreed, and noted that policymakers and taxpayers will need to understand that reaching CO_2 reduction goals will be more expensive than "business as usual." He noted that timing will be driven by industry, and the government can help by providing targets through programs such as the California ZEV mandates or through a Phase 2 vehicle demonstration program.

- Dr. Schmidt expressed concern about the portfolio approach, questioning whether the public and private sectors will be able to carry the cost of bringing multiple vehicle platforms to market (e.g., President-elect Obama's proposal for one million plug-in hybrids) especially as these different technologies will be competing for money that will be hard to find in this difficult financial climate.
- Mr. van Dokkum reminded the Committee that the end goal is to significantly reduce CO_2 emissions, and that "everybody who studies the science can figure that FCVs or hydrogen-powered vehicles are ultimately the only way to get there." He believes there will be a natural conversion to HFCVs (perhaps even plug-in HFCVs, if the electric grid system is cleaner and more efficient than it is today) because that is ultimately how you get the best performance out of an automobile. Ultimately it will be a combination of these platforms that will succeed in reaching the end goal.
- Dr. Schultz expressed concern about Dr. Gronich's statement regarding meeting the challenge of reducing CO_2 emissions by 80 percent by 2050—that this will be game-changing and a lot more expensive. Dr. Schultz agreed that there will be transition costs, but that there are a number of studies that indicate that "once the dust has settled…what we pay for transportation will be less expensive than if we extrapolated business as usual out to 2050." Dr. Gronich disagreed, and noted that many past studies did not factor in the full cost of a clean electric grid, for sequestering carbon from coal, and so forth. He cited the recent Kromer and Heywood MIT report, *Electric Powertrains: Opportunities and Challenges in the U.S. Light-Duty Vehicle Fleet*, (http://web.mit.edu/sloan-auto-lab/research/beforeh2/files/kromer_electric_powertrains.pdf) and the recent NAS studies on hydrogen, which estimate that battery electric and FCVs will have higher costs than conventional vehicles.

5. *Review of Talking Points and Discussion of Policy Visibility for Hydrogen and Fuel Cells*
>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_nov08.html

Dr. Shaw (Chair of the HTAC Policy and Planning Subcommittee) presented a draft two-page "talking points paper," which was developed by the HTAC Policy and Planning Subcommittee on the basis of comments and discussion at the May and July 2008 HTAC meetings. The talking points paper is intended to help educate President-elect Obama's transition team and energy policymakers. Dr. Shaw stated that it should be part of HTAC's objective to ensure that the hydrogen option does not get "taken off of the table" and that it is included in President-elect Obama's plans for developing green technologies for a new energy economy, which is reportedly one of the new administration's top priorities.

Mr. van Dokkum reported that in his work with the Obama energy team, the focus has been on developing general performance standards (e.g., low carbon footprint, high efficiency), as opposed to selecting specific technologies. Mr. van Dokkum also said that the team has not talked much about hydrogen as an enabler for renewable energy as a storage option; the focus has been more on the fuel mix and what can be done to overhaul the electric grid so it can better take on and transport power from renewables.

Dr. Shaw stated that the purpose of the HTAC discussion of the talking points is to (1) review the current draft talking points and reach consensus on a version that can be posted to the HTAC website and communicated to the transition team, and (2) discuss the strategy for making contact with the transition team, the new Secretary of Energy, and other energy policymakers.

5.1 Discussion of HTAC Talking Points

Dr. Shaw opened the floor to suggestions on the draft talking points from the HTAC members. The comments from members are summarized below.

- Start off with numbers that demonstrate the potential value of hydrogen, not just in CO_2 benefits but also in terms of its value in helping address the long term issue of peak oil production. (Dr. Ramage)
- Many of the transition team members do not know much if anything about hydrogen, so it will be important to educate them so that they know the facts. (Dr. Ramage)
- Beginning with "hydrogen is being used in today's economy" is not especially compelling—a lot of things are used in today's economy. (Dr. Taylor)
- The intent for starting off with "hydrogen is being used in today's economy" is to make the point that hydrogen is not a "space age," exotic product that no one knows anything about using. It is a commodity chemical that is already shipped all around the country. We are simply talking about using it for a different purpose. (Dr. Shaw)
- The draft is focused on the automobile. We should give specific examples of how hydrogen can be used in the home and everyday life to make people more comfortable with it. (Dr. Richmond)
- The use of hydrogen and fuel cells for distributed power generation is an important non-automotive application to emphasize. Also, the talking points paper needs to have a harder hitting title, such as "Hydrogen and Fuel Cells: A Leadership Option for Our Nation's Energy Security and Carbon Footprint Reduction." (Mr. Hofmeister)
    - Instead of "Leadership Option" it should be "Leadership Imperative," to make the point that if we really want to address the oil and CO_2 challenges, this is not an "option" (Mr. Eggert)
- Emphasize that we can make all of the hydrogen we need with domestic resources, which addresses the energy security aspect. (Mr. Novachek)
- Stress early in the document that hydrogen is the only way to achieve all the goals—energy independence, 80 percent reduction in CO_2 by 2050, and reductions in other pollutants. (Mr. Novachek)
- Biomass should be mentioned as a promising low-cost source. (Mr. Eggert)
- Emphasize the need to start now—the statement "nearly zero by 2050 if we start the rollout quickly" could benefit from more precise language, for example: "nearly zero by 2050 if we invest in the development and deployment of these technologies *today*." (Mr. Eggert)
- Emphasize that government incentives and coordination are needed to support the national deployment of infrastructure and vehicles. (Mr. Eggert)
- The word "effluent" should be replaced by "combustion products" or "emissions." (Mr. Eggert)
- Need to allude to hydrogen's role in jobs, the middle class, and a vital economy—as part of the "next industrial revolution," which is a fundamental reason for using hydrogen on a sustainable basis: include the words "industrial revolution" in the title or the lead-in sentence/paragraph of the talking points. Pursuing hydrogen and fuel cells is not just a technical solution—it creates an industry and jobs. (Dr. McCormick)
    - Rather than including it as part of the first paragraph, add a "super paragraph" that summarizes the new industrial revolution concept. (Dr. Schultz)
    - The problem with adding a super paragraph about the "next industrial revolution" is that

    the rest of the points become more or less irrelevant and other key points are missed. (Dr. Shaw)

- Include a clear value proposition with numbers that catch attention. (Dr. Ramage)
- Lead with a couple of long-term benefits (i.e., why do we care about this?). (Dr. Ogden)
- Convey the message that hydrogen will not just reduce GHG emissions to near zero, but reduce air pollution to near zero, cut oil use, diversify resources, and enable renewables, and that hydrogen is part of a new, industrial, clean energy system. (Dr. Ogden)
- The hydrogen effort over the past 10-15 years should not in any way be construed as "failed policy." We need to get across the message that tremendous technical progress has been made and the funding has been well spent. As a result of developments by industry and government, hydrogen technology has come along dramatically and most of the major automakers now see a roadmap to commercialization starting at the 2015 (or so) timeframe. (Dr. Ogden)
- Make sure the statement conveying the need for government incentives also conveys the message that these subsidies are only needed for the transition period—they will not be needed forever. (Dr. Ogden)
- As a whole, the draft talking points paper has the right tone—it does not over-promise, and it is factual and persuasive. (Dr. Schultz)
- The draft talking points includes a sentence suggesting that the size of the investment needed to build out the required hydrogen infrastructure is not really the hurdle some believe it to be. However, it is actually an enormous hurdle for a particular business segment (gas station owners) and should not be downplayed. (Mr. Vesey)
    - It may not be the gas station owners who ultimately take this on—it may be the industrial gas companies, the auto companies or auto dealers, or others who step up into this business opportunity when the vehicles are ready. (Dr. Shaw)
    - It will be relatively easy to build the infrastructure once the market opportunity presents itself. The size of the incentives needed to support infrastructure build-out is also relatively small. There is no need for the talking points paper to go into details on specific hurdles or strategies for addressing them—that will take the focus off of the more salient points we want to make. (Mr. Katsaros)
- The technical progress made over the last years has definitely diminished the financial and technical hurdles associated with hydrogen and fuel cells. However, we do not want to make the case for hydrogen overly positive because there are issues that still need to be addressed, such as codes and standards, logistics, and carbon capture and sequestration, and these should be included in the talking points. (Dr. Ramage)
- The great advantage of hydrogen is that it unifies all of the energy strategies the Obama campaign has talked about pursuing. It would be good to include a statement that says something like this: "Hydrogen represents a clear, near-term path to unifying clean U.S. energy strategies—solar, wind, clean coal, natural gas, biomass, nuclear, etc.—into a common infrastructure for transportation, distributed power generation, and consumer technologies." (Congressman Walker)
- The Department of Energy recently published a study estimating the number of jobs that would be created: *Effects of a Transition to a Hydrogen Economy on Employment in the United States Report* (http://www.hydrogen.energy.gov/pdfs/epact1820_employment_study.pdf). These numbers (375,000 to 675,000 jobs in the next 25 years) could be included in the talking points. (Dr. Milliken)
- From the DOE perspective, the only thing missing from the talking points is the portfolio approach, but that idea appears to be captured in the suggested edits from the HTAC members. (Dr. Milliken)

5.2 Discussion of HTAC Strategy for Meeting with Policymakers in New Administration

After some discussion of various options, it was agreed that the HTAC would form a sub-group of three or four HTAC members who would meet with the transition team (and their appointees) and the new Energy Secretary to convey the HTAC talking points. The sub-group members should comprise a balanced viewpoint (e.g., a technologist, a policymaker, and a businessperson's perspective). The HTAC Chair and Vice Chair should send a letter to the DOE transition team asking for a meeting as soon as the talking points are finalized and the appointments are made. It was also suggested that a briefing book be assembled for the transition team, to include the HTAC talking points paper, the recent NAS study on hydrogen, and the letter the HTAC sent to the Secretary on the findings of the NAS study.

Dr. Shaw asked if the HTAC's letter to Energy Secretary Bodman, on the subject of the key findings of the recent NAS study, had been formally transmitted. Ms. Epping-Martin responded that the letter had been sent to the Secretary. Dr. Shaw asked DOE to send all the HTAC members a copy of the final, signed letter that was sent.

6. *Discussion of Annual Report*

The first HTAC Annual Report will be produced by the HTAC for the Secretary of Energy in early 2009. The report will be a concise, 5-page summary of 2008 progress and setbacks in hydrogen and fuel cells. Dr. Shaw led a discussion on additional ideas and inputs for the planned HTAC Annual Report. He presented the results of an email survey of HTAC members, in which he asked for inputs on major 2008 hydrogen and fuel cell accomplishments, news, reports or events. The box below summarizes the inputs from HTAC members received via email and during the discussion session.

Additional Questions, Answers, and Discussion

HTAC Annual Report Resources and Information

Key Reports
- NAS report on the Hydrogen Transition and key findings
- NAE Review of the FreedomCAR and Fuel Partnership
- H_2 Program Annual Progress Report & Annual Merit Review and Peer Review Findings
- GAO report "Advanced Energy Technologies: Budget Trends…"
- GM/Shell infrastructure report and key findings
- CaFCP vision paper
- NHA report on the Hydrogen Transition
- DOE jobs study
- EU report(s) on hydrogen infrastructure, e.g., HyWays
- FC Seminar charts from METI

Product Introductions and Events
- APCI fueling station deployment at "record pace"
- APCI Hydra liquid trailer for delivery of liquid or gaseous hydrogen at 10,000 psi
- Growing market for materials handling systems (forklifts) has created backlog at APCI for associated H_2 production and dispensing products
- Construction of the first 100% renewable tri-generation (CHP and H_2) station from municipal waste water treatment biogas
- Hydrogen Road Tour
- Honda and GM's initial deployment of FCVs to consumers: GM's Project Driveway
- Ford's new 700-bar fueling station in Dearborn, MI
- New hydrogen permitting in all markets
- Stationary fuel cell being offered with 80,000-hour fuel cell stack warranty

- DOE: provide top-5 technical (R&D) accomplishments
- FCVs continue to progress rapidly
  - Stack durability/cost reduction
  - Achievement of 250+ mile range
- Ford Focus fuel cell vehicle fleet of 30 vehicles achieves one million miles of road operation (move to Product events section?; include other OEMs)
- Safety: (DOE to include bullet on safety?)
- Nearly every OEM working on fuel cell power trains has announced that they can now:
  - Start up the fuel cell system from -25°C or lower and in less than 90 seconds
  - Store hydrogen onboard with 700 bar systems, extending driving range
- Demonstration of a REDOX cathode for PEM fuel cells that eliminates the need for platinum catalyst (international work, not validated?)
- Arizona Public Service and NETL progress on substitute natural gas from hydrogen and coal
- DOT approval of new technology/processes
  - Special permits issued
  - New codes and standard being accepted by DOT and FAA

Policy Initiatives
- €1.0 billion EU Fuel Cell and Hydrogen Joint Technology Initiative (JTI)
- Germany's NOW program
- Daimler, AG announced that it will work with energy companies to build a hydrogen fueling infrastructure in Germany
- Workshops are being held to educate fire and building

- DOE was asked to provide data on Federal procurements and usage, and reported the following:
    - ~40 fuel cell forklifts planned for procurement by the Defense Logistics Agency
    - ~45 back-up power fuel cell units planned for procurement by the Federal Aviation Administration and the Department of Defense
    - 20 HFCVs and hydrogen internal combustion engines (ICEs) in service in Federal fleets (DOE, EPA, USDA, DOD, USPS)
    - Army awarded $1.75 million prize on fuel cell for wearable power
    - 60 new hydrogen fueling stations in 2008 (Federal and non-Federal)
- The audience for the annual report, per Dr. Shaw, is the Secretary of Energy but “with the intent that this would also go to Congress and to a broader audience.” Mr. Eggert stressed the need to “translate” the scientific findings into more tangible results, such as converting hydrogen storage material weight capacity to a driving range. Dr. Ogden agreed that translation is important. Dr. Shaw concurred and stressed that the final writing would take the intended audiences into consideration.
- Mr. van Dokkum cautioned the Committee to include all the relevant details when citing scientific data. For instance, the automotive fuel cell membrane electrode assembly with 7,300 hours of durability is only an important achievement when it is noted that the membrane has low platinum loading. Dr. Shaw agreed, and stressed the need for a thorough review process to catch this type of issue.
- Mr. Novachek agreed to send Dr. Shaw more information on the Arizona Public Service-NETL project on a process to make substitute natural gas using hydrogen from renewable resources and coal gasification.
- Dr. Ramage suggested including at least one chart that shows the major technology milestones and their progress over the last five years.
- The Committee agreed that the inclusion of expanded fuel cell income tax credit provisions in the bank rescue package (*Emergency Economic Stabilization Act of 2008*) was the top policy event this year. Mr. van Dokkum agreed, adding that the eight-year time horizon gives potential fuel cell purchasers more comfort when making a long-term investment. DOE agreed to provide the HTAC with the ITC provision summaries that have been produced by the U.S. Fuel Cell Council and by DOE.
- Dr. McCormick agreed to provide data on the number of first responders that have been trained to deal with hydrogen incidents through the Project Driveway Program. Mr. van Dokkum agreed to provide similar data for the California Fuel Cell Partnership. DOE also tracks the number of people trained through their programs. Mr. Narva can also help with data on training of code officials, etc.
- Mr. Katsaros and Dr. McCormick described the circumstances of a fire at a hydrogen fueling station in White Plains, New York. As described in an Air Products/Shell press release, all the hydrogen in storage burned, but did not explode, and the damage was contained to the device that caused the fire (a 700-bar compressor). The safety systems reacted as designed, shutting the pump down, and the local fire department was dispatched automatically. While a fire may be considered a setback, all the safety systems worked as designed and no one was injured. Mr. Eggert suggested terming this and the FCV crash in Germany (which also did not result in any injuries) as “incidents” as opposed to “setbacks” since all the safety systems worked as designed. These incidents could actually be included as progress in a “Safety” category.

7. ***Comparison of NHA and NAS Resource Studies***

Dr. Sandy Thomas, President, H2Gen

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_nov08.html

Dr. Thomas provided the Committee with a detailed report on the National Hydrogen Association (NHA) study *The Future of Hydrogen: An Alternative Transportation Analysis for the 21st Century* and its corresponding analysis results, and compared them to the recent National Academies of Science (NAS) National Research Council study (*Transitions to Alternative Transportation Technologies—A Focus on Hydrogen*). Mr. Novachek explained that the NHA commissioned its study in October 2007 in order to compare hydrogen with other alternatives (e.g., ethanol, plug-in hybrids, battery vehicles, etc.) Dr. Thomas's company, H2Gen, was one of a number of organizations that contributed to the study. Dr. Thomas was responsible for producing a number of the simulations and scenarios used to draw the comparisons, and he largely reported on the results from these simulations and scenarios, as compared to the NAS study results.

Dr. Thomas noted that the NHA study set out three goals for an ideal transportation system: (1) reduce GHG emissions 80 percent below the 1990 levels; (2) reduce oil consumption in the transportation sector to a level where the amount of oil consumed in the light-duty vehicle sector would be small enough that domestic oil production could provide all other (transportation and non-transportation) oil needs; and (3) reduce urban air pollution. The study analyzed what was then best for society to meet those goals: hybrids, plug-ins, biofuels, fuel cells, BEVs, natural gas vehicles, or all/some of the above. He reported that the NHA study came to the same conclusion as the NAS report—a "portfolio" of technologies that includes HFCVs is needed to achieve all those goals, simultaneously. In terms of fuels, hydrogen and electricity (and, to a more limited degree, ethanol) are needed to achieve a truly sustainable energy system and provide for transportation fuel needs.

The topics covered by the presentation included:

- NHA hydrogen study board organization and members
- NHA study overall approach and key assumptions
- Analysis results for projected market penetration rates, GHG emissions, oil consumption, and urban air pollution for hybrid gasoline vehicles, plug-in hybrid gasoline vehicles, plug-in ethanol vehicles, natural gas, BEVs, and HFCVs (among others)
- Analysis results for projected hydrogen infrastructure costs compared with (1) the costs to green the grid, (2) the cost of current investments made by the oil and gas industry, (3) societal savings relative to alternative technologies, and (4) spending on other government projects
- Comparisons between NAS and NHA studies of FCV market penetration, hydrogen infrastructure costs and revenues for a station owner, fuel economy, GHG emissions, and oil consumption

Questions, Answers, and Discussion

- Dr. Ramage observed that the NHA data presented a more realistic scenario based on a lower penetration rate and lower efficiency rate, in contrast to the NAS study, which was intended to demonstrate the maximum penetration rate. While the NHA and NAS studies were conducted independently and used different penetration rates, they both reached the same conclusions regarding when the hydrogen deployment must be started, how much it will cost, the price comparison with other alternatives such as ethanol, and the year in which the investment in hydrogen infrastructure will break even. Dr. Thomas agreed with Dr. Ramage's assessment.

- Dr. Ogden noted that one of the main differences in the cost analyses conducted for the NHA and NAS studies was that the NAS study calculated the buy-down costs for HFCVs as part of the total transition cost, whereas the NHA study did not calculate or include any vehicle costs. She questioned whether the NHA had intentions of incorporating the vehicle-side costs into their study. Dr. Thomas replied that the NHA would rely on the NAS study for the vehicle cost calculations; the NHA study was focused solely on hydrogen infrastructure costs.
- Dr. Ogden requested clarification on whether the social costs calculated by the NHA included any vehicle or fuel costs or whether they were solely the externality costs (e.g., impact of air pollution, etc.). Dr. Thomas confirmed that the calculated social costs in the NHA study were strictly the externality costs, including the societal costs of oil.
- Congressman Walker asked whether the NHA study considered simply subsidizing the price of hydrogen (as is done with ethanol) rather than creating a more complicated system for distributing subsidies to station owners, etc. Dr. Thomas agreed that that would be one way to approach lowering the cost of hydrogen, but noted that the NHA is continuing to lobby Congress for a tax credit for hydrogen refueling systems similar to those available for stationary fuel cell systems.
- Dr. Ogden noted that both the NHA and NAS scenarios include, along with HFCVs, very efficient ICEs and/or plug-in hybrids (with a large biofuels component) as part of the vehicle mix until relatively late in the century. She noted that the NHA vehicle scenario is similar to Case 4 of the NAS study, except that the NHA study uses more plug-in hybrids while the NAS study uses very efficient gasoline ICE vehicles and some biofuels in their projections.
- Mr. Hofmeister inquired how the transition team, the ethanol lobby, the compressed gas lobby, and the utility lobby, all of whom are pushing plug-in hybrids, would critique the NHA study. Dr. Thomas replied that the NHA conducted a number of sensitivity studies to address these kinds of questions. For example, NHA looked at a scenario with 100% plug-in hybrid penetration and determined that the plug-in hybrid still does not lower GHG levels to 80% below 1990, the goal of the incoming administration. Analogously, battery-powered vehicles would be at a disadvantage, when compared with HFCVs, because they would need to be heavier and larger to accommodate batteries to power a vehicle for a 200–300 mile range. For plug-in hybrid and electric vehicles, the marginal grid mix is used by NHA to calculate the GHG emissions. In the marginal grid mix, coal plant power generation will increase during the night to re-charge the vehicles. Dr. Ogden commented that the marginal choice depends on the location of the plant: while coal is more likely in areas like the Midwest, California may utilize natural gas. Ultimately, the marginal grid mix and its operation will be especially relevant around the time frame of 2030–2040 and beyond, when plug-in hybrids will be a larger portion of the U.S. fleet. Dr. Thomas commented that one of the aforementioned groups may refute the marginal grid mix approach in favor of an average grid mix approach.

8. *Open Discussion*

Congressman Walker opened the discussion up to any additional items from the members. No additional discussion points were raised.

The Committee then discussed potential dates and agenda items for their 2009 meetings, and set a tentative schedule as follows:

- February 18–19, 2009: Washington, DC.
    - Review and final acceptance of the Annual Report (Dr. Shaw, 1-2 hours).
- July 15–16, 2009: Northeast location, to be determined.
    - Possible side visits to fuel cell manufacturing or research facilities
- November 4–5, 2009: location TBD

The November 6, 2008 HTAC meeting was adjourned at 5:30 pm.

November 7, 2008

Chairman Walker called the meeting to order at **8:35** a.m.

1. *Public Comment Period*

Ms. Epping-Martin reported that no one from the public had pre-registered to make public comments before the Committee. Chairman Walker opened the floor for public comments. Hearing none, the comment period was closed.

2. *Review of US-EU Technology Collaboration, JTI, and IPHE Meetings*

Dr. JoAnn Milliken, Hydrogen Program Manager, DOE

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_nov08.html

Dr. Milliken, who spoke in place of Mr. Michael Mills, presented on international hydrogen activities: (1) the 10th International Partnership for the Hydrogen Economy (IPHE) Steering Committee Meeting, (2) an overview of the European Commission's Joint Technology Initiative (JTI), and (3) the bilateral European Union-United States hydrogen science and technology activities.

The topics covered by the presentation included:

- An overview of the hydrogen activities of United States (US), European Union (EU), Germany, and Japan, in areas such as funding, demonstration activities, incentives, and other activities
- 10th IPHE Steering Committee Meeting -- key actions and decisions
- An overview of the JTI, including structure, participants, governing board members, budget, and targets
- Description of EU-U.S. collaborations, in diverse areas including codes and standards, international collaboration, and a manager/scientist exchange program

Questions, Answers, and Discussion

- Dr. Milliken confirmed that the "International Overview" chart showing hydrogen-related activities and funding in the US, EU, Germany and Japan (slide 3) does not include the United Kingdom (UK). Dr. Shaw noted that the UK has a fairly active program, and asked how their activities are accounted for. Other Committee members mentioned a number of other countries whose activities were not presented in the International Overview chart, and recommended that DOE revise the HTAC presentation material to include the UK, France, Israel, China, Spain, Italy, Netherlands, Denmark, Scandinavia, the Middle East, and any significant others. Dr. Milliken noted that the current presentation focused on the EU, Japan and Germany because they have the largest hydrogen programs outside the United States, and also because the data was available. DOE will continue to update this material as the data from other countries is made available. Later in the meeting, Dr. Shaw pointed out that the data shown in the International Overview slide under-reports the extent of the activity in the EU and Germany. Dr. Milliken noted that, as shown in the footnote, the data only includes the Clean Energy Partnership; DOE will update this slide with more complete information, as available.

- In response to a question from Dr. Shaw about the number of small, entrepreneurial companies on the JTI Governing Board, Dr. Milliken noted that 64 companies are included in the "Industry Grouping" of the Governing Board, with a good balance between large companies and "SMEs" (small and medium enterprises). She took an action item to send the HTAC a list of the companies on the JTI Governing Board.
- Congressman Walker asked whether the Daimler-Germany work to build hydrogen fueling stations was part of the JTI. Dr. Milliken replied that is a separate activity being undertaken by the German government and Daimler, but that it is coordinated with the JTI.
- On the "Targets and Milestones" slide, Dr. Milliken questioned the data point shown for the JTI's 2015 transportation fuel cell system cost target (100 €/kW, or about $137/kW). Her understanding from discussions with the Europeans was that the target was $75/kW. In any case, she agreed that the EU targets for fuel cell system and hydrogen costs are higher than the U.S. targets. She reported that the DOE cost targets are currently being evaluated and will likely be revised upward to reflect changes in oil prices, fuel economy, emissions regulations, etc. Dr. McCormick added the EU's 2015 targets are for the cost at which commercialization should begin (i.e., at low-volume production) while the DOE targets have historically been developed to show what the cost would be at a mass-market penetration (high-volume production). Dr. Milliken agreed, and said that targets for low-volume production are one of the issues the DOE Hydrogen Program will be addressing as it revises its targets.
- Asked about the level of enthusiasm for hydrogen deployment in Europe, Dr. Milliken responded that she perceived quite a bit of enthusiasm and commitment from both the European Commission and industry, and "a feeling that this is going to happen." She also noted that the discussions included similar concerns to those expressed in the U.S. hydrogen community about "dilution" of the hydrogen message with the increasing visibility of plug-in hybrids and biofuels. Mr. van Dokkum expressed his opinion that the formation of the JTI represents a strategic decision on the part of European governments and industries to coordinate efforts and get more aggressively involved in hydrogen and fuel cell development. Dr. McCormick added that the hydrogen fueling stations in Germany look like real commercial stations. He perceives a more commercialization-focused mindset in Europe than in the U.S., and noted that this mindset will encourage more active participation by industry. Dr. Schmidt cautioned against an overly optimistic assessment of the business climate in Germany and the rest of Europe. He noted that while there are some strong industry partners, there are other companies who are completely ending or reducing their hydrogen and fuel cell programs, and many others who are in a "wait and see" mode. Mr. van Dokkum and Dr. Shaw agreed, but reiterated their feelings that the JTI will catalyze increased industry activity on hydrogen and fuel cells in Europe.
- Dr. Shaw urged DOE to continue their awareness of and involvement in the small venture community (national and international), since these entities are the source of many innovations and "know no national boundaries." Dr. Milliken agreed and expressed her belief that the JTI would provide a good mechanism for DOE to interact more with the European small business and entrepreneurial community.
- In response to a question from Mr. Eggert, Mr. Garbak (DOE Technology Validation Team Leader) reported that there are efforts underway, through the IPHE's Demonstration Working Group, to compile a database on international demonstration projects. So far, the member countries have provided only general overviews of their demonstration projects; a detailed plan for data collection on both vehicles and infrastructure is being developed. DOE is also working with the German government and with the JTI to coordinate data collection on their demonstration projects.

- Mr. Rose suggested that, with a limited amount of time to focus on overseas activities, DOE may want to focus on working with the individual countries that are getting more active in hydrogen and fuel cells (e.g., Germany and Denmark).
- Dr. Shaw reported on some of the activities being undertaken in the Middle East, such as, (1) the planned construction in Abu Dhabi of "Masdar City," to be the world's first zero-carbon, zero-waste city; and (2) proposals to build large solar installations to produce hydrogen for pipeline shipment to Europe. He urged DOE to stay abreast of these, and other major international, activities and to get involved in them if possible. Dr. Milliken noted that Assistant Secretary Karsner had increased DOE's international activity in his tenure and she expected that this would continue in the new administration. Mr. Rose asked Dr. Milliken to let HTAC know if DOE would like their help facilitating international interactions.
- Mr. Hofmeister observed that the presentation on international activities makes clear that there is a major global need for alternatives to hydrocarbon fuels. While it could be argued that America's reliance on imported oil is more about business practices than available domestic reserves, Europe and Japan clearly face more profound, near-term needs for alternative energy. He argued that this "speaks to the need for a clearer industrial strategy around hydrogen because of geopolitical positioning elsewhere." He suggested that the HTAC include the geopolitical issues in their talking points as both a threat and an opportunity. Mr. Rose agreed, and asked Dr. Milliken whether there were any specific actions the HTAC could take to facilitate DOE's international activities. Dr. Milliken could not think of any, but suggested that the HTAC could communicate their position on international collaboration activities in their Annual Report.

3. *Briefing on Solid Oxide Fuel Cells*

Mr. Wayne Surdoval Technology Manager, Fuel Cells, Office of Fossil Energy, NETL/DOE and Dr. Nancy Garland, Acting Fuel Cell Team Leader, HFCIT, DOE

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_nov08.html

Mr. Surdoval presented a background of the Solid State Energy Conversion Alliance (SECA), the goals of the DOE's Office of Fossil Energy Advanced (Coal) Power Systems, a comparison of different carbon capture systems, and an overview of SECA industry teams and their 5kW prototypes.

The topics covered by the presentation included:

- The organization of high-temperature fuel cell R&D within the Office of Fossil Energy
- SECA program structure and explanation of the balance that intellectual property brings to the alliance (highest bidder vs. best designs)
- DOE Office of Fossil Energy Advanced (Coal) Power Systems goals
- The SECA Performance Assessment Rating Tool
- An analysis of the size of both the overnight truck auxiliary power unit (APU) and coal markets
- An overview of the process behind SECA coal based systems
- Current and future integrated gasification combined cycle (IGCC) technologies with carbon capture
- A comparison of the carbon capture efficiency, cost of electricity, and capital cost of different carbon capture systems
- An overview of SECA industry teams and their 5-kW prototypes

Dr. Garland followed with a presentation on small stationary fuel cell R&D in EERE and current EERE solid oxide fuel cell (SOFC) projects: their pros, cons, and challenges.

The topics covered by the presentation included:

- An overview of small-scale (1-10kW) stationary fuel cell R&D in EERE
- Current EERE SOFC projects (>10kW) including:
    - Diesel fueled SOFC's for on-highway truck auxiliary power from Cummins power generation
    - Auxiliary power in heavy duty vehicle applications from Delphi
    - Tubular SOFC power system from Acumentrics
    - Low-cost co-production of hydrogen and electricity from Bloom Energy, Inc.
- Future work in SOFC's

Questions, Answers, and Discussion

- Mr. Surdoval responded to a question from Dr. Shaw by explaining the relationship between power density and voltage and its relationship to cell longevity. He reported that many of the fuel cell systems operate at much higher power densities than 300mW/cm^2. However, when setting the target, they chose a low power density goal so as not to impact the engineering tradeoff between density and voltage and therefore drive innovation towards the wrong targets. By decreasing the power density, the economics are enhanced because performance and durability are improved.
- Mr. Garbak pointed out that the slide on growth in coal power generation capacity in the U.S. (slide 10) implies that SECA-type fuel cells will be the dominant technology for new generation capacity beyond 2018. Mr. Surdoval agreed that this is what the Energy Information Administration is projecting.
- Dr. Ogden questioned the cost of electricity (11.6¢/kWh shown for the reference case—advanced pulverized coal—in slide 17). Her understanding is that these costs are closer to 6 or 7¢/kW. Mr. Surdoval explained that the numbers shown in this chart include costs for carbon capture (but not for sequestration). He also clarified that efficiency was reported as power input divided by power output.
- Mr. Eggert expressed his appreciation of the efficiency figures reported for the advanced fuel cell power systems and asked how far the technology was from actually being implemented in a full scale plant. Mr. Surdoval explained that there are scale-up issues that must be dealt with. He expressed his confidence with the cost estimates, although he reminded the Committee that the models are based on assumptions.
- Mr. Surdoval has been very pleased with the progress the SECA research community has made on fuel cell durability and does not see any major technical hurdles. He believes fundraising for a large coal demonstration will be a bigger barrier to deployment than technology, due to the large investments needed for such a demonstration.
- In response to a question from Dr. Schultz, Mr. Surdoval explained that the 2010 capital cost figure he presented for a SECA fuel cell system (<$400/kW in slide 9) is not the total power plant cost but just the cost of the fuel cell power block, which would replace the existing power generating unit. The estimated capital costs for the entire power plant are shown on slide 17.
- When asked by Dr. Shaw about the SECA auxiliary power unit (APU) program, Mr. Surdoval explained that the SECA program never intended to specifically develop APUs; they were developing a "mass customizable technology that could be used [in] virtually any application." The intention

behind funding 5-kW projects was not to limit the applications to 5-kW; DOE considered 5-kW to be the smallest device on which to economically test the devices. There is the potential to deploy this same stack technology for many applications, including APUs for trucks and coal-based power generation. Dr. Shaw stressed vehicle APUs as a good high-volume application to quickly develop the early fuel cell market. He asked whether any of the SECA industry partners were prepared to introduce this technology to market now; Mr. Surdoval responded that R&D is still underway, and Dr. Garland stated that she would be covering R&D on SOFC APUs in her presentation.

- In response to a question from Mr. Kaya, Mr. Surdoval explained that a SECA plant could be designed to produce both hydrogen and power (by recovering hydrogen from the stack gases) if the economics were positive.
- When asked about the interest from utility companies on the high-temperature SOFCs, Mr. Surdoval replied that most of their partners are the equipment suppliers, not utilities. Mr. van Dokkum agreed, explaining that the utilities see SOFCs as a research project and not yet as a development effort because there are significant technical hurdles to overcome: temperature cycling, high temperature management, corrosion, materials fatigue, and other issues. He added that while SOFC is a very promising technology, "there's still a lot of work to be done to make sure that [the design] indeed holds up long term in the field." If the technology can work in a coal plant and help resolve carbon management issues, it will be very interesting to utilities, but it has to be proven first. He also noted that, if proven, SOFC technology could have applications in aircraft, since they can be operated on conventional jet fuels.
- Mr. Eggert asked about the geometry of the Acumentrics system (tubular vs planar), and the prospects for scaling up a tubular system for larger-scale applications. DOE replied that the tubular system is best suited for smaller-scale applications because of the volume to surface area ratio limitations.
- Dr. Shaw asked if there are performance issues to overcome or whether the factor limiting SOFC APU deployment is only cost reduction. Dr. Garland explained that deployment delays are primarily cost based—demonstrations conducted to date have not identified performance problems.
- Dr. Garland confirmed that the current 5-kW APU units have a 60-minute start-up time. However, the fuel cell would not need to be turned on or off as often as a diesel generator and therefore the startup time would be less of a problem.

4. *HyWays-IPHE: Comparison of U.S. and EU Roadmapping Activities*

Dr. Mark Ruth, National Renewable Energy Laboratory

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_nov08.html

Dr. Ruth spoke on the hydrogen roadmapping activities being done within the United States and in the European Commission (EC). He also presented a comparison of the socioeconomic modeling and vehicle modeling techniques utilized by the two different analysis efforts.

The topics covered by the presentation included:

- The project scope, methodology, and partners
- A comparison of the different delivery pathways modeled
- Evaluation of the financial parameters used
- Comparison of hydrogen cost, energy use, and GHG emissions results
- Key differences in socio-economic and vehicle modeling

- Plans for information transfer between the U.S. and EC

Questions, Answers, and Discussion

- Dr. Shaw asked whether Dr. Ruth presumed that the distributed generation option does not survive past 2015 (slide 8). Dr. Ruth responded that the set of production pathways (and timeframes) selected for the comparison was chosen on the basis of what model-based analyses had already been completed by both the U.S. and the EC. The nine pathways selected are not meant to be a recommendation or forecast of what will actually occur in the future. He agreed that onsite steam methane reforming could be extended well into the 21st century.
- Mr. Eggert noted that the Pathway Cost Comparison slide showed the greatest disparity between the EC and U.S. models in the pathways for integrated gasification combined cycle (IGCC) and central SMR with pipeline distribution (slide 16). Dr. Ruth explained that these technologies are harder to model (and therefore more likely to produce inconsistent results) since they are farther from commercialization, and that assumptions about efficiency, capital costs, the value of products, etc. have a big impact on the results.
- Dr. Ogden commented that the hydrogen production mix from the U.S. Markal model (slide 22) is not very different from the National Academy of Science (NAS), except that NAS had a larger role for biomass. Dr. Ruth agreed, and pointed out that the modeled hydrogen production results shown for the EC (HyWays) and the U.S. (Markal) on slide 22 are not as different as they appear because the two charts are presented in different scales. While the EC reaches 4500 pJ of hydrogen production by 2050, the U.S. achieves 3500 pJ.
- Congressman Walker asked why nuclear hydrogen production was not included as a pathway. Dr. Ruth said that although nuclear hydrogen production is modeled in Markal, it was not selected as a pathway for comparison in this timeframe.
- When asked about the differences between the vehicle cost and performance model results (Europe's ADVISOR model and the U.S. PSAT model, slide 24), Dr. Ruth agreed that more work is needed to understand the differences between the models and to harmonize the results.
- Mr. Garbak asked Dr. Ruth to characterize, from the perspective of a policymaker, the substantial qualitative differences between the conclusions of the EC and U.S. analyses. Dr. Ruth responded that there are several significant differences, including the diversity in production technologies and energy supplies. The energy mix used in the EC analysis was much more diverse than that of the American analysis because the EC analysis required a certain renewable energy fuel component. He also noted that while the study did not compare potential policy options that the two regions might propose, based on informal discussions among the study group he would expect some significant differences due to the varying societal structures.
- Dr. Schultz remarked on the modeling results for the hydrogen production mix, which in the U.S. is forecasted by the Markal model to be mostly fossil-fuel based. He said that he was not surprised by this result, since in his experience with previous H2A analyses, the models are biased towards fossil fuels: they have unrealistically low estimates of what fossil feedstocks will cost; very high capital cost interest rates, which penalize the renewables, nuclear, or other capital-intensive technologies; and they lack a CO_2 penalty. He added that if this is the path on which the nation is headed, that maybe the assumptions need to be changed in both the model and the reality it reflects. Dr. Ruth cautioned against mixing modeling with policy, and stated that the modeling was performed to answer a specific question, which was, "What would be the lowest cost pathway to achieve that level of hydrogen

production?" He noted that scenario analysis is capable of incorporating added constraints into the U.S. models to explore the effects of regulations or polices, such as renewable portfolio requirements and CO_2 penalties.

5. *Briefing on DOT/DOE Hydrogen Road Tour*

Mr. Paul Brubaker, Administrator, Research and Innovative Technology Administration, U.S. Department of Transportation

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_nov08.html

Administrator Brubaker provided HTAC with a report on the August 2008 Hydrogen Road Tour, which visited 31 U.S. cities in 18 states in 13 days. The Road Tour included hydrogen vehicles provided by nine vehicle manufacturers and mobile hydrogen refuelers supplied by three industrial gas companies. Over 1,600 citizens test drove the vehicles, eleven members of Congress participated, and over 8,500,000 viewers were in the television audience of the mainstream media coverage.

The topics covered by the presentation included:

- Organizers of the road tour and the tour vehicles and industrial gas companies which took part
- The various events hosted in the stops: media, static, ride & drive, and refueling
- Event turnout totals
- Video, print, and online media coverage
- Tour accomplishments
- Plans for a 2009 International Hydrogen Road Tour from Baja, Mexico to British Columbia, Canada

Questions, Answers, and Discussion

- Dr. Shaw asked whether the Hydrogen Road Tour team had considered ways to make the road tours a more frequent event that would allow the public to view the FCVs once a week or month in major metro areas with existing fuel supplies (New York, NY; Washington, DC; and Los Angeles, CA). Administrator Brubaker answered that the Hydrogen Road Tour is not the only event in the United States to showcase the cars—for example, the State University of New York–Albany showcases the cars as part of its SummerFest, the California Fuel Cell Partnership regularly sponsors ride-and-drives, and Enterprise Rent-A-Car has expressed interest in having an FCV in the Washington D.C. area to rent out for short periods of time. Dr. McCormick commented that the Project Driveway program (which includes 100 FCVs) regularly takes the cars to a range of events at universities, fairs, etc., and the demand to view or drive the cars is overwhelming at these events (300 to 400 drives per day).
- Dr. Shaw discussed the grassroots/viral marketing potential showcase events in the major metro areas. He suggested that having more showcase events (to allow hundreds of thousands of people to test-drive the cars) would build a groundswell of public support and demand for hydrogen cars. Dr. McCormick commented that the Project Driveway provides website where users communicate about their experiences with driving the FCVs. Administrator Brubaker commented that outreach events are already building interest and demand, even though the necessary infrastructure is not yet fully in place to support consumer use of hydrogen cars. He encouraged any viral marketing or enhanced outreach effort to build demand in line with product and infrastructure availability, lest a negative

experience be created. For example, he reported that during the Hydrogen Road Tour, there were comments from people who were disappointed that they could not yet purchase the cars they were viewing and test-driving. Administrator Brubaker added that in building any kind of grassroots or viral support for hydrogen cars, it will be important to tap into the demographic of younger adults. Dr. Shaw also commented on the effort required to facilitate one million test drives, calculating that one million 15-minute test drives could be achieved using 100 vehicles at 2,500 hours each (i.e., one-fourth of a year).

- Mr. van Dokkum noted that public transport buses (and other public fleet vehicles such as mail delivery trucks) are a way to increase visibility of hydrogen and fuel cells and that he has heard positive feedback from the public on the use of fuel cell buses. Administrator Brubaker commented that the Federal Transit Administration (FTA) has an active fuel cell bus program that will place 17 buses on the road by 2011, and that the next Surface Transportation Authorization Bill will be a key way to get a small number of new hydrogen fuel cell bus fleets on the road. He also mentioned that the United States Postal Service has presented plans to upgrade its fleet, and this represents a key opportunity to get many more hydrogen vehicles on the road.
- Mr. Kaya discussed the "call to action" aspects of a possible increase in showcase events in the major metro areas, suggesting that facilitating one million test drives could lead consumers to pressure Congress to hasten the development and market entry of hydrogen vehicles. Chairman Walker asked whether the Hydrogen Road Tour included any efforts by industry to provide the end-users with a postcard they could forward to their local Congressman or Representative to encourage greater support for hydrogen vehicles. Administrator Brubaker suggested that such efforts would need to be separated from the government role in the ride and drive events, and these efforts could possibly be self-organized and executed by manufacturers under the auspices of the trade associations or interest groups.
- In response to a question about lessons learned from the DOT Road Tour, Dr. McCormick suggested that events like this should be arranged further in advance, because often the vehicles are reserved months in advance. One OEM, for instance, was only able to participate in certain legs of the Road Tour because the vehicles were already promised at other events.
- Mr. Hofmeister discussed the important role of celebrity sponsorship in generating grassroots demand for hydrogen vehicles. He added that it is difficult for government officials to secure these celebrity sponsorships, but the National Hydrogen Association may be better positioned to do so, and this would be a productive role to play. Chairman Walker commented that an event on Capitol Hill featuring a celebrity like Jay Leno or Jamie Lee Curtis (who have hydrogen cars) would be a great way to generate publicity.
- Dr. McCormick commented on the importance of universities (especially university transportation centers) in any marketing/outreach effort, commenting that university hydrogen events already draw high interest and large crowds from the student body and faculty. Dr. Ogden agreed, adding that universities with sustainability programs would have especially enthusiastic audiences. She noted that there are many sustainability events held at universities and many student networks and virtual groups dedicated to these topics across the country. Administrator Brubaker added that a collaboration network (something like a social networking website) is about to be formed around communities of interest in the DOT's University Transportation Centers. It is hoped that the network will expand to include the entire transportation research community.

6. ***Open Discussion***

Chairman Walker opened the floor for additional discussion. Hearing none, he thanked the participants for their input and closed the meeting.

7. ***Adjourn***

The November 6-7, 2008 HTAC meeting was adjourned at approximately ***12:00*** *p.m.*

Ninth Meeting of the

Hydrogen and Fuel Cell Technical Advisory Committee (HTAC)

Participant List

November 6-7, 2008

HTAC Members Present:

- Larry Bawden
- Anthony Eggert
- John Hofmeister
- Arthur Katsaros
- Maurice Kaya
- Byron McCormick
- James Narva
- Frank Novachek
- Joan Ogden
- Michael Ramage (November 6)
- Geraldine Richmond
- Robert Rose (November 7)
- Gerhard Schmidt
- Ken Shultz
- Robert Shaw
- Kathy Taylor
- Jan van Dokkum
- Greg Vesey
- Robert Walker

HTAC Members Not Present:

- Mark Chernoby
- David Friedman
- Janice Hicks
- Alan Lloyd
- Philip Ross

U.S. Department of Energy Staff

Office of Energy Efficiency and Renewable Energy

- Sara Dillich
- Kathi Epping-Martin

- Rick Farmer
- John Garbak
- Nancy Garland
- Jamie Holladay
- Fred Joseck
- JoAnn Milliken
- Mike Mills
- Sunita Satyapal

Office of Fossil Energy

- Mark Ackiewicz
- Lowell Miller
- Wayne Surdoval

Office of Nuclear Energy

- Carl Sink
- Stephen Kung

Office of Science

- John Vetrano

U.S. Department of Transportation Staff

- Paul Brubaker
- Stephen Costa

Members of the Public in Attendance

- Judith Bayer – UTC Power
- Rodrigo Chaparro – Numark Associates, Inc.
- John Christensen – Defense Logistics Agency
- Bud DeFlaviis – U.S. Fuel Cell Council
- James Fabunmi – American Heritage Defense Corporation
- Leo Grassilli – U.S. Navy
- Sigmund Gronich – Charisma Consultants
- William Haris – U.S. Army
- Rebecca Held – Numark Associates, Inc.
- Jerome Hinkle – National Hydrogen Association
- Karl Jonietz – Los Alamos National Laboratory
- Carole McGuire – Lewis-Burke Associates
- Jonathan Munetz – Sentech, Inc.
- Mark Ruth – National Renewable Energy Laboratory
- Jeff Serfass –Hydrogen Education Foundation
- Neil Snyder – National Renewable Energy Laboratory

- Joseph Stanford – Sentech, Inc.
- Sandy Thomas – H2Gen Innovations, Inc.
- Brynne Ward – U.S. Fuel Cell Council

Support Staff

- Judi Abraham – Conference Management Associates, Inc.
- Anna Domask – Energetics Incorporated
- Melissa Lott – Alliance Technical Services, Inc.
- Kevin McMurphy – Sentech, Inc.
- Shawna McQueen – Energetics Incorporated
- Walter Zalis – Energetics Incorporated