HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE

MEETING MINUTES – DRAFT

February 18-19, 2009

Crystal Gateway Marriott, Crystal City, VA

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February 18, 2009

1. *Call to Order, Agenda Review*

Chairman Walker called the meeting to order at 8:34 am and requested Dr. Janice Hicks from the National Science Foundation to tell the Committee a little about herself since she missed the opportunity to do so during her brief attendance at the July 2008 meeting. Dr. Hicks described herself as a physical chemist by training, with a keen interest in developing a national science and technology workforce that can accomplish a new energy plan for the country.

Chairman Walker reported that he met with the new Secretary at the Department of Energy (DOE) on February 17, and provided him with a copy of the HTAC talking points. During the meeting, Secretary Chu expressed his interest in hydrogen technology, particularly stationary fuel cells, which he views as a maturing technology with relevance in a number of different applications. He recognized their near-term potential in various "discrete" applications such as forklifts, postal vehicles, buses, and the like, all of which have central fueling. He questioned where the large volumes of hydrogen, beyond natural gas

reforming, would come from. Secretary Chu considers solar and wind promising options but wondered about the demand on the electric grid from increased use of electrolyzers. Chairman Walker conveyed the possibility for hydrogen to serve as an energy storage medium at wind or solar farms, which was of interest to the Secretary. Chairman Walker did not get the sense that the Secretary fully understood the recent advances that had been made in the field. For example, he was surprised to learn of the progress in the costs of automotive polymer electrolyte membrane (PEM) fuel cell systems, which DOE's cost model projects to $73/kW. He also was not aware that researchers at Idaho National Laboratory have demonstrated hydrogen production using simulated heat from high-temperature, gas-cooled, nuclear reactors; he thought this research was still in the paper-study phase. Chairman Walker reported that Secretary Chu is a very astute scientist and asked a lot of probing questions as they reviewed the HTAC talking points. Chairman Walker thinks the Committee has a good opportunity to provide a resource for the Secretary and build his information base. Secretary Chu had not read the recent National Academies report on hydrogen, but asked his staff to get a copy to provide to him. Chairman Walker characterized Secretary Chu as someone who recognizes some applications for hydrogen in the near future but is still skeptical about whether and when a hydrogen distribution network could be built for mass transportation needs.

Questions, Answers, and Discussion

- Chairman Walker was not sure if the Secretary was aware of the cooperation between the auto and energy companies in field testing hydrogen vehicles and infrastructure – the subject did not come up. Secretary Chu did mention the vehicle deployments by Honda, but noted that so far the manufacturers are only leasing the vehicles to customers.
- Asked whether Secretary Chu expressed an opinion about fuel cell buses, Congressman Walker replied that the Secretary viewed anything that could be fueled centrally as an option but was skeptical about large distributed infrastructure for automobiles.

2. *Further Perspectives on the Role of Hydrogen in the Administration*

Chairman Walker opened the floor for a general discussion of the role of hydrogen and energy in the Obama Administration. The key points made by members were:

- Mr. Friedman relayed a comment made by President Obama in one of his recent speeches: the President stated that he does not want to ask the same questions about energy 30 years from now. Mr. Friedman noted that interest in alternative energy tends to wane as energy prices go down, so one challenge will be to keep the pressure on for alternative energy even in the face of lowering oil prices. He also noted the tendency for people to want immediate or simple solutions ("silver bullets") and asserted that it is incumbent on the HTAC to convey the message that hydrogen needs to be a part of the solution, but it is not a silver bullet. In fact none of the options, including plug-in vehicles or biofuels, are a silver bullet; there is uncertainty around all these technologies so we must advocate for a portfolio of options. Mr. Hofmeister echoed Mr. Friedman's concerns about low energy prices and their effects on renewable energy investment. Multiple infrastructures cannot all be built due to cost, and increased investment in a 100 year old technology that will be, at best, 20% efficient is not the answer.
- Dr. Shaw expressed disappointment that the provisions in the Stimulus Bill do not provide more emphasis on energy investments as a means for stimulating the economy. He referred to an early

campaign speech by President Obama (Portsmouth, NH, October 7, 2007), in which then-Senator Obama laid out his vision to make America a global leader on energy, and create new industries and jobs. He hopes that the Energy Bill will do more to deal with energy, economy, infrastructure, climate change, and jobs "all under the same umbrella," as implied in that campaign speech. Chairman Walker noted that the Department of Energy is still trying to get their political appointees in place, which can slow the process. Mr. van Dokkum observed that while he was "disappointed that hydrogen has not yet found its place in the talking points," he was pleased to see the "big boost" in the Stimulus Bill for building energy efficiency, solar, wind, and geothermal. He is encouraged by the administration's new direction towards energy efficiency and renewables, but noted that the Committee needs to concentrate on bringing hydrogen to the attention of Secretary Chu and members of President Obama's staff.

- Mr. Rose informed the Committee about a White House website that lays out the President's principles for energy policy (http://www.whitehouse.gov/agenda/energy_and_environment/). He observed that the President appears to focus on symbolic things, like 40 million smart meters, five million jobs, and one million plug-in hybrids, and at present hydrogen and fuel cells "have a hard time competing in that arena." He thinks that hydrogen and fuel cells may be viewed by some in the current administration as a way "to avoid doing anything on motor vehicle efficiency." In addition, the frequent use of the term "long term" when describing hydrogen and fuel cells is a "killer" since there is still no real long-term thinking coming out of Washington. He thinks the biggest challenge is convincing people that all of the strategies – Gen-2 biofuels, plug-ins, etc. – are in practical reality long term and expensive to implement.
- Mr. Eggert agreed with the previous comments, adding that he thinks the HTAC goals and the Administration's principles are "very well aligned." He pointed to the Administration's support for a diverse energy supply system, renewable energy, and clean coal (which is an enabling technology for hydrogen). He believes that Secretary Chu has "sophisticated skepticism" about hydrogen, which could be swayed by "technically meritorious arguments," which is where he thinks the HTAC can have the biggest impact. He noted that the President seems to be emphasizing good science in policymaking through his appointment of people like Secretary Chu and Dr. Holdren (White House science advisor). He asserted that if the HTAC can "make the strong technical case for hydrogen and its potential to deliver on their energy and environmental principles, I think we've got a good chance of making [hydrogen] a priority of the new Administration."
- Mr. Hofmeister pointed out that a key concern for the Administration has to be what oil prices will be in four years when they are up for re-election, not what oil prices are today. He stressed that there is indeed a need to "leap frog" away from the inefficient internal combustion engine, but the "proliferation of infrastructures to fuel people's vehicles is not the answer." He noted that there are a lot of options for alternative vehicles and transportation fueling infrastructures being discussed, but that in the end, a successful transportation infrastructure has to be ubiquitous and as simple as you can make it. He believes the decisions made on carbon management in the next several years will be "crucial on how this plays out over the longer term." He also believes that the economic recovery will show the age of the nation's current energy infrastructure, with more than 90% of the hydrocarbon and nuclear energy infrastructure nearing the end of its normal lifetime. He stressed the need to focus on all these longer term issues, and not just what is politically popular today.
- Mr. Friedman agreed that, in the long run, a "proliferation of infrastructures" is not desirable. However, he believes that, "for the next 10 years, we're going to have to suffer through a proliferation of infrastructure to get there because of the amount of uncertainty." He does not think

that we have enough information to choose among the options, and believes that "we're going to be in a very uncomfortable position of living with uncertainty and trying to get money to fund continuing that uncertainty for a little while before we can choose."

- Dr. Schultz noted that the Administration appears to be modestly pro-nuclear, or at least not anti-nuclear, based on his assessment of President Obama's speeches, his cabinet appointments, and language in the Stimulus Bill. Continued support for nuclear power, according to Dr. Schultz, can provide an assured, long-term, carbon-free source of hydrogen, which would answer one of Dr. Chu's questions about where the hydrogen might come from.
- Mr. Friedman questioned the notion that spending on hydrogen really belonged in the Stimulus Bill, since he did not see how it would immediately generate significant amounts of jobs or economic stimulation. He did, on the other hand, hope to see money for hydrogen in the upcoming Energy Bill. He pointed out that the Committee should be careful to target its "asks" towards the areas where hydrogen can offer the greatest impact. Chairman Walker agreed, adding that he expects to see pushback against items in the Stimulus Bill that will not immediately create jobs. He also would like to see hydrogen as part of a "coordinated energy strategy" rather than part of the "grab bag" that was the Stimulus Bill. Mr. Rose disagreed strongly with the notion that there is not a commercial fuel cell industry today poised to make and sell fuel cells. While they may not yet be selling fuel cells to automakers, there is a "big universe" of other nearer term markets that is increasing in size daily, and the industry is ready today. Chairman Walker agreed, and reiterated Secretary Chu's interest in stationary fuel cells as near-term technology. Dr. Shaw noted the Administration understands that the energy problem is longer term, and a big impact on carbon emissions in 2050 will require actions starting today. He suggested the message must be that there is technology we can put in the field today to build an industry that can make a difference for the future.
- Dr. Ogden noted that the transformation towards clean energy, whatever options are pursued, will require a long view and commitment. She suggested that one of the key points to raise with science advisors in the Administration is the National Academies study finding that "the amount of money to stay in the game with the uncertainty and to continue to play a portfolio of approaches that include hydrogen, plug-in hybrids, battery vehicles, biofuels, and carbon sequestration, among other things, is not that huge."
- Mr. Novachek conveyed his opinion that the United States is "kind of lost" compared to Europe and Japan. He explained that it is all well and good to support wind, solar, and smart grids. But "when you put it all together, you better have storage or the whole thing doesn't work. Smart grids don't work unless you have storage. Renewable power is limited unless you have storage." He said that European countries understand these issues and are starting to do some work to address the system-level issues for using renewable power.
- Mr. Chernoby suggested that the Committee should follow up on the information about where Secretary thinks there are opportunities for fuel cells, and help him understand the opportunities for and benefits of stationary fuel cells. Whatever the applications or funding levels, the important thing is to "keep hydrogen on the table."
- Mr. Hofmeister stressed that "what really makes things happen in this country" is the "trilateral marriage of industry, NGOs [non-governmental organizations], and civil service." These groups provide "continuity through the political process" as well as a scope that extends beyond national boundaries. When we work in the mutual interests of these groups we can make steady prolonged progress.

- Dr. Taylor portrayed education as a "shovel-ready project." She thinks the Committee has a role in advocating the need for education in developing entrepreneurs for the future. People who are out of work or in dying industries want to be educated, so this is a good opportunity to use some of the stimulus money to support that education and start building the workforce of the future.
- The state of the national and global economy concerns Dr. Shaw. He thinks there is a need for a big, fresh, new national initiative that will restore confidence and trust and "galvanize people" (similar to, but on a larger scale than, Roosevelt's Work Projects Administration). He thought renewable energy investment could be the initiative that could "tie the country together." Renewable energy production could stimulate the economy in the short term and hydrogen would be an essential part of that infrastructure through its ability to store energy. He believes that we could choose to start investing right away in things like wind, solar, and photovoltaics, to create jobs very quickly and tie together solutions for the economic crisis, automotive crisis, and climate and ecosystem crises. He thinks international cooperation will be key, since the economic and environmental challenges are global in nature. Chairman Walker agreed, explaining his belief that the economy is changing fundamentally, but we have not adjusted to it as a society, since the constituency for the "old system" is stronger and more numerous than the constituency for the "new system." He cited the Stimulus Bill as an example, saying that we "continue to fund the candle-makers at a time when the electric light bulb is becoming the new reality." He agreed that is a need for "a fundamental change of philosophy about where we're headed."
- Mr. Rose let the Committee know about a new study by General Motors and Sandia National Laboratories on whether and how a large volume of cellulosic biofuel could be sustainably produced by 2030. The "90-Billion Gallon Biofuel Deployment Study" http://HITECtransportation.org/news concludes that plant and forestry waste and dedicated energy crops could sustainably replace nearly a third of gasoline use by the year 2030. According to Mr. Rose, the study's cost projections show that hydrogen can compete on price with biofuels, with much better CO_2 benefits.
- Mr. Rose reported that international activity in hydrogen and fuel cells is accelerating. Japan is moving aggressively on consumer electronic devices and residential fuel cells, and the U.S. will struggle to compete. Germany is also investing heavily in residential combined heat and power fuel cell systems. India appears to be trying to take over the manufacture of small PEM fuel cell systems, and the auto industry is also talking with Chinese and other offshore manufacturers. There is an urgent need to create and protect U.S.-based jobs in this industry; without quick action, the U.S. will be buying these technologies from overseas.
- Mr. Hofmeister described a "big notion idea" he has been presenting to various groups "outside the Beltway." He explained that his idea is predicated on two key points. Point One: the Federal Government is "dysfunctional when it comes to energy." Since 13 Federal agencies, the White House, and 26 Congressional committees and subcommittees govern energy, making rational, reasonable, and long-term policy is almost impossible. Point Two: the Federal Reserve System has delivered 95 years of relative financial stability in the United States, in large part because the Board is empowered to make the "big rules" on the monetary system and because it is non-political. Mr. Hofmeister proposes that the nation consider creating a "federal energy reserve board" that would have the same kind of big rule capability for energy as the Fed has for money. The big rules could include "managing the energy supply proportionately to the future needs of the nation" (e.g., how much from hydrocarbons, how much from nuclear, how much from various renewables, etc.). The energy board could also make the big technology choices and provide Federal direction on energy infrastructure investments. Lastly, the board would regulate carbon footprint by establishing long-

term parameters. The federal energy reserve board should be run like the Fed, as an independent regulatory agency in which the President appoints governors for seven-year terms and "advises and consents" on their decisions. Given the complexity and the volatility of the energy system, Mr. Hofmeister believes this kind of central authority is needed, and he is advocating for it on a grassroots level in order to build support for the idea in the absence of a real crisis. Mr. Friedman asked what "levers" the federal energy reserve board would be able to use to regulate energy. Mr. Hofmeister responded that the board could set targets (e.g., "by 20XX the U.S. energy supply will be made up of x, y and z"); Congress would then be challenged to set the enabling laws, incentives or penalties to make that happen. The carbon footprint would also be a tool, he explained, if the board were to set a CO_2 emission goal, with penalties for not meeting the goal. He did not have an answer for how the board might set the "big rules" for technology, but for infrastructure he suggested that the board could, for example, say that the nation needs a particular set of transmission lines and then pressure Congress to enact legislation that would enable those transmission lines to be built in a timely fashion across multiple jurisdictions. Mr. Friedman also wondered whether such a board would find support in industry, since it would likely be perceived as "technocratic" and/or not adequately democratic. Mr. Hofmeister agreed with this concern by saying he does "not see either industry or sitting government supporting the idea," which is why he is choosing to present the idea at the grassroots level.

- Dr. Ogden agreed that grassroots movements can be powerful forces for social change, and suggested that the Committee consider states as "laboratories" for new policies or initiatives. She noted that a number of hydrogen analyses have focused on the idea of beginning infrastructure and vehicle rollouts in select "lighthouse" cities or lighthouse regions, with build-out from there. In this way success in one area can catalyze success in another.
- Mr. van Dokkum spoke on Jeremy Rifkin's idea of the "Third Industrial Revolution." According to Mr. Rifkin, the Third Industrial Revolution is being catalyzed now by the convergence of renewable energy, partially stored in the form of hydrogen, and smart communication technologies that will support the proliferation of distributed energy systems. Mr. van Dokkum noted that European governments and companies have "rallied around" the concept, but it has not yet received much "traction" in the U.S.
- Mr. Eggert expressed his interest in holding an HTAC discussion on "the appropriate role of government as we go into the next stage of deployment." He would like the Committee to consider in more detail the kinds of polices that could be enacted at the Federal level, and specifically define what policies (e.g., R&D policy, tax policy, investment and demonstration policy, etc.) will take us to the next phase of commercial deployment.
- Chairman Walker thanked the Committee for the discussion and noted that there seems to be consensus that "macro policy" must be formulated that includes hydrogen as part of the infrastructure going forward, and that part of HTAC's role should be to help define (and communicate in their reports) what some of those policies should be. Another take-away from the discussion, according to Chairman Walker, is that there are a series of "micro-policies" (things that can be done immediately) that would have an economic impact now and help spur the industry. He suggested that HTAC's role could be to make sure the DOE Hydrogen Program "is reflective of both of these streams of activity," in the sense that the Committee is "pointing towards the right policies while at the same time supporting the industry in making sure it has the technical capabilities to move forward in the economic sense."

3. *Discussion with New Deputy Assistant Secretary for Renewable Energy, Jacques Beaudry-Losique*
Jacques Beaudry-Losique, DOE, Office of Energy Efficiency and Renewable Energy (EERE)

Dr. Milliken introduced Mr. Beaudry-Losique, explaining that he began his service at DOE in 2005 as the Program Manager for EERE's Industrial Technologies Program. After about one-and-a-half years there, he was appointed to the Program Manager position in the Office of Biomass. In his two years with the Biomass Program, he significantly accelerated biofuels deployment activities, and was appointed to replace Steve Chalk as the Deputy Assistant Secretary for Renewable Energy when Mr. Chalk became the Principal Deputy Assistant Secretary for EERE. Dr. Milliken described Mr. Beaudry-Losique as someone who brings a lot of experience in business development, executive management, and commercial negotiations to DOE. As the business development leader of General Electric Power Systems investment activities, he was responsible for the placement of equity investments into strategic technology companies, including Plug Power, a leading fuel cell developer and manufacturer. He also worked on business development at Aspen Technologies, a leading engineering and supply chain software development company; he worked as Chief Financial Officer of Acumentrics, a company that is developing solid oxide fuel cell technologies, and he has experience running his own company.

Mr. Beaudry-Losique spoke to HTAC on his view of the Hydrogen Program. The key points he emphasized were:

- Thanking the Committee for their service to the government.
- Noting that the EERE Hydrogen, Fuel Cells & Infrastructure Technologies (HFCIT) Program is one of the "most professionally managed programs at DOE" and has been well reviewed by multiple independent bodies.
- The HFCIT Program has been refocused towards "more practical shorter-term applications," such as forklifts and off-grid stationary applications such as back-up power, to help overcome the challenges to commercialization.
- Going forward, there needs to be a better understanding of how hydrogen fits within the EERE and the nation's portfolio.
- From a personal view, Mr. Beaudry-Losique thinks that an integrated transportation strategy for the nation is needed to define the goals and the pathways for getting there, including the timing that might be expected for the different technologies and infrastructure elements.

Questions, Answers, and Discussion

- In response to Dr. Shaw, Mr. Beaudry-Losique expressed his view that it is premature to speak on future hydrogen funding levels. He did say that in the short-term, funding would likely stay reasonably steady. He expressed his view that, "we have an opportunity to put our best foot forward and make this program [as] relevant to the new Administration as it was to the previous one."
- Mr. Beaudry-Losique highly values the expertise provided by the HTAC, and pledged, as he did with the Biomass Technology Advisory Committee, to gather and use their input in DOE plans.
- Mr. Eggert observed that "one of the great things about the Hydrogen Program was that it was able to cut across a lot of the existing [DOE] programs [including] fossil energy and nuclear energy." He asked whether the Deputy Assistant Secretary (DAS) sees opportunities going forward to further

integrate these programs, particularly the potential for hydrogen from biomass, to take advantage of potential synergies. Mr. Beaudry-Losique replied that it will be important to form effective working relationships among programs like wind, solar, biomass, fossil and nuclear, especially with regard to hydrogen production. He said one of his questions in this regard is "how much hydrogen do we need by when?" And what kind of hydrogen production and storage capacity will we need over time? Mr. Rose mentioned the Hydrogen and Fuel Cells Interagency Task Force (ITF) and the Hydrogen and Fuel Cells Interagency Working Group (IWG) as two groups that work to deploy fuel cells within the Federal government. He wanted to be sure Mr. Beaudry-Losique was aware of their importance in the deployment of hydrogen and fuel cell technology.

- Dr. McCormick pointed out that a lot of the Committee's discussions have revolved around hydrogen's ability to play a unique role in synthesizing, tying together, or enabling a number of different possibilities for producing, storing, and using energy. "Whether you call it 'hydricity' where electrical and hydrogen tie together, or whether you recognize that the electrical grid and transportation tie together with hydrogen as part of that synergy." He asked the DAS how the HTAC could help in providing the information he needs to create the "storyline" for the integrated strategy that he alluded to earlier. Mr. Beaudry-Losique noted that he cannot yet speak for the Administration, since DOE does not yet have many of its senior management appointments in place. However, he would personally like the development of an integrated transportation strategy to be a high-priority goal for the Department, and would like the HTAC, as well as other third party advisory groups, to actively participate in developing the strategy.
- Chairman Walker asked whether there was anything specific the Committee should address in their Report to the Secretary later this year. Mr. Beaudry-Losique said that he would be interested in the Committee's input on:
    - What's the "state of the union" on where we are today with hydrogen, both for transportation and stationary applications? What progress has been made; what challenges remain; how and when can hydrogen fit into an "integrated transportation strategy"; and what are the steps along the way to full implementation of both transportation and stationary applications?
    - Are we at the stage where we can begin large-scale demonstration programs (like in the Biomass Program) or do we still need to focus on resolving technical challenges through R&D?
    - Recommendations on funding -- what funding areas need the most attention / where would the impact be the greatest?
    - Recommendations regarding storage technologies that would enable hydrogen to be part of the transportation infrastructure (where should the government apply resources?)
    - Need to answer the questions "how much hydrogen do we need by when? And where will it come from?"
    - Recommendations regarding how hydrogen can be an enabling technology for (in Mr. Schultz's words) "extending and making more accessible our remaining fossil fuel resources; mitigating CO_2; levelizing and storing intermittent renewable energy; and providing off-peak load for nuclear."
- Mr. Friedman asked whether Mr. Beaudry-Losique would be interested in holding an annual or semiannual meeting that brings together DOE's Federal Advisory Committees, such as the Biomass R&D Technical Advisory Committee and HTAC. Mr. Beaudry-Losique thought that was an excellent idea.

- Mr. Friedman asked for Mr. Beaudry-Losique's personal opinion on whether DOE may be ready to "look beyond the direct mission of EERE, mainly focusing on RD&D, …to sponsor broader policy initiatives that go beyond RD&D." He noted that a consistent message from the HTAC (and supported by the National Academies study) has been that RD&D is just the first step – policies will be needed for hydrogen, or any of the energy alternatives, to work. The DAS explained that EERE, as a Federal agency, does not typically go to Congress with policy initiatives. If asked by Congress for advice, they will provide analysis. He noted that the HTAC can "recommend to Congress certain directions" that DOE might then need to address. He asserted that this is "one of the purposes of HTAC." He also noted that the Biomass Program over the last couple of years has spent a large percentage of their budget on demonstrations (about 55% of the budget), which has "helped us develop a potentially substantial infrastructure across the country."
- Dr. Schultz asked what the Committee can do to "encourage the recognition of hydrogen's enabling role across the broad number of programs" (renewable energy, fossil energy, nuclear energy. Mr. Beaudry-Losique believes the new Administration will be very interested in exploring this question and it could be a part of the overall "business plan." He said the Administration is "looking very favorably [at] things that…can be accomplished in the short- or medium term," so HTAC's suggestions in this regard would be helpful. He clarified that the typical definition of timeframes within the EERE programs would place 2012 as "short-term," 2015 as "medium-term," and 2020 to 2050 as "long-term." He did not yet know how the new Administration would define those timeframes.
- Mr. Katsaros asked Mr. Beaudry-Losique why there has been little mention of hydrogen in the new Administration's discussion about how to solve the nation's energy problems. Mr. Beaudry-Losique believed it was because of a focus on the "immediate renewables" like solar and wind and the need for the Administration to explore their own new areas. However, he asserted that there is "an open mind about hydrogen and a lot of talk about what's the best way to apply hydrogen going forward." He explained, "the ball's in our court to really work and develop a plan that will help solve these problems going forward." He encouraged the Committee to ask the new Secretary and the new Administration the same questions.
- Dr. Shaw portrayed the Committee's concern that, although much of the hydrogen and fuel cell technology has been invented and developed in the U.S., much of it will likely be commercialized abroad. He asked Mr. Beaudry-Losique to carry his message to the new Assistant Secretaries and other officials. Mr. Beaudry-Losique agreed that American competitiveness in these technologies is important, and he explained this message is easy for him to convey, since he has seen the same thing happen with other technologies, i.e., wind, solar, and batteries.
- Mr. Rose offered a comment on some of the existing mechanisms for increasing the deployment of commercial fuel cell systems. He stated that "Congress recognized the value of the Department of Energy in stimulating early purchases of fuel cells via Section 782 of the Energy Policy Act for vehicles and Section 783 for stationary, portable, and micro fuel cell systems." He commended DOE for "getting some momentum behind that program [which] is dearly beloved by the fuel cell industry as an opportunity to provide systems to the government that serve their needs while stimulating additional production in the United States." He noted the two interagency task forces that have been exploring these opportunities, and he hoped the DAS has been briefed on these activities. He conveyed that the mechanisms are there and if the "Department wants to move more aggressively, they will find a willing industry."

4. ***Hydrogen Program Comments on: (1) GAO Recommendation on Targets and (2) the Stimulus***
Dr. JoAnn Milliken, Department of Energy

4.1 Comments on Funding in the Recovery Act: Dr. JoAnn Milliken, Hydrogen Program Manager, DOE

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_feb09.html

Dr. Milliken presented an initial examination of hydrogen and fuel cell provisions in the "American Recovery and Reinvestment Act of 2009" (H.R. 1). In short, the $787 billion (B) appropriated by the Recovery Act provides $33.3 B for energy, broken down as follows:

- $16.8 B for DOE Office of Energy Efficiency and Renewable Energy
- $2 B for DOE Office of Science (including $400 million for the Advanced Research Projects Agency)
- $3.4 B for DOE Office of Fossil Energy R&D
- $4.5 B for DOE Office of Electricity Delivery & Energy Reliability (Smart Grid)
- $6 B for DOE Loan Guarantee Program
- $309 million (M) for General Services Administration (includes high performance green federal buildings and fleets)
- $300 M for Department of Defense energy research, including fuel cells

The other topics covered by the presentation included:

- Detailed breakdown of the $16.8 B appropriation for EERE, which includes $2.5 B for RD&D (with language specifying $800 M to Biomass, $400 M to Geothermal, $50 M to Industrial Technologies and $50 million to data centers, leaving about $1.2 B of "discretionary funding" for other EERE RD&D programs).
- A summary of new or expanded fuel cell tax credits.
- A summary of provisions that offer expanded funding opportunities for fuel cells, even if fuel cells are not specifically mentioned (e.g., provisions providing funding to increase energy efficiency in Federal buildings and public housing).

Questions, Answers, and Discussion

- Dr. Milliken explained DOE is working now on identifying projects that will be funded with this money, and the recovery.gov website provides a transparent process for reporting those projects and their outcomes. Creating jobs is a very important aspect of the Recovery Bill, so getting the money obligated quickly is an important part of the process and will likely result in accelerated schedules for planned solicitations or funding opportunity announcements. She clarified that the funding provided by the Recovery Act must be obligated within two years but that the programs or projects it funds could continue beyond that two-year period using annual appropriations.
- Mr. Eggert asked whether there were specific cost-share requirements for the $2.5 billion allocated to EERE's R&D efforts. Dr. Milliken answered that the Recovery Act does not mention cost-sharing requirements. DOE will continue to follow the cost-share guidelines provided in the Energy Policy

Act of 2005: 20% minimum cost share for R&D projects and at least 50% for demonstration and deployment.

- Mr. Rose commented that the two tax credits for hydrogen fueling infrastructure (Section 1623 for hydrogen fueling facility tax credits and Section 1721 for grants for energy property in lieu of tax credits) are only two-year provisions. He suggested it would benefit the industry if the fueling facility tax credit was enlarged and if both tax provisions were extended.
- Mr. Rose wondered how much of the funding to EERE could "realistically be in play with fresh requests for proposals," given the deadlines for getting the funding obligated. Dr. Milliken responded that she cannot answer this question because the Department is still developing plans within the programs. She noted that some of the funds would certainly be used to accelerate or expand existing projects or ready-to-be-awarded projects from recent solicitations. The programs will also consider "alternate projects" from previous solicitations that were deemed meritorious but could not be funded because of funding limitations.
- Mr. Hofmeister noted that Secretary Chu had been quoted in the press as saying that "DOE was not well equipped to spend money quickly." He asked what changes the DOE would be making to distribute funds more efficiently. Dr. Milliken stated that the Department is working on streamlining solicitation and procurement processes and management is talking with each of the programs to ensure they are funding projects that meet Recovery Act objectives. Chairman Walker added there is genuine concern over the ability of small programs to quickly utilize significantly increased budgets. Mr. Beaudry-Losique agreed it is an enormous challenge, but noted that Congress did include some provisions in the Recovery Act to address this challenge, such as an expedited hiring process for Federal and contractor staff and a mandate to streamline NEPA requirements. He also noted that the Secretary has authority to waive or reduce cost-sharing requirements in order to expedite project funding
- Returning to the concept of synergies, Mr. Eggert commented that states are also receiving stimulus funds, and are going through the same exercises of trying to maximize their potential value. He wondered whether anyone is pursuing opportunities for DOE (or other Federal agencies) to collaborate with state energy offices to "assist in pooling together some of these funding pots to make an even greater potential benefit." Dr. Milliken responded that the Department would definitely leverage its contacts at state energy offices to communicate potential opportunities within these activities.
- Dr. Taylor noted that in EERE's stimulus funding, the largest amount was for weatherization projects, and asked what kinds of projects the stimulus includes and whether there will be any new activities. Dr. Milliken responded that the weatherization activity is a formula grant program that assists people in weatherizing their homes, and not an R&D program.
- Mr. van Dokkum warned that just as the DOE may have difficulty in allocating the funds it receives, the hydrogen and fuel cell technologies development community would have difficulty absorbing the funds. The supply-chains and manufacturing facilities are not large enough to fully handle the potential amount of funding in a two-year timeframe. In general, Mr. van Dokkum stated at least two years would be needed to build up the infrastructure needed by the industry to handle the sudden increase in demand. While this timeframe may not achieve "instant gratification," it would, he said, help a lot with commercialization. Mr. Rose added that the same would be true for most industries facing a sudden increase in demand, and it is a "problem" the fuel cell industry would like to have.

- Mr. Rose asked whether the Committee could provide any guidance on how to allocate the $1.3 billion of discretionary EERE R&D funds. Dr. Milliken stated that the process of allocating those funds was essentially complete, thought it is still being "tweaked" within the Department.

4.2 Hydrogen Program Response to GAO Comment on Targets: Dr. JoAnn Milliken, Hydrogen Program Manager, Department of Energy

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_feb09.html

Dr. Milliken presented a briefing on the Hydrogen Program's response to GAO recommendations in their 2008 report on the Hydrogen Fuel Initiative. She described the GAO review as generally positive. Major findings were that DOE has made important progress in all the R&D areas; the program has generally managed its R&D resources well; the program is coordinated well among federal agencies; and outside experts are adequately engaged in the program planning and assessment stages. The main GAO recommendation was to "update its 2006 Hydrogen Posture Plan to reflect what it reasonably expects to achieve by the technology readiness date of 2015." She explained that the 2015 technology readiness goal is based on meeting "critical path" cost and performance targets for automotive applications of hydrogen and fuel cell technologies. Meeting these targets will enable those technologies to be competitive in the marketplace and enable industry to decide whether or not to commercialize. She noted that the program works with the energy and automotive industries to re-evaluate the targets on a regular basis, and the hydrogen production, storage and fuel cell R&D programs are currently re-evaluating their targets to take into account the many changes in technology, prices, regulations, and real-world operating data sets over the past five years.

The topics covered by the presentation included:

- An overview of the GAO's review process
- A summary of the GAO findings regarding:
    - Program Management and Process
    - Remaining Challenges and Gaps
    - Main Recommendation (provide clarity on 2015 "Technology Readiness")
- DOE's response to GAO recommendations
- A summary of the current DOE targets for:
    - Critical path technologies (for hydrogen production, on-board hydrogen storage, and automotive fuel cells)
    - Other program areas (e.g., for longer-term hydrogen production, stationary and portable fuel cells, and hydrogen delivery)
- DOE's ongoing efforts to re-evaluate hydrogen and fuel cell targets
- Back-up slides provide more detail on status and targets for hydrogen production, delivery, storage, fuel cells (including stationary fuel cells); and data from DOE's technology validation program.

Questions, Answers, and Discussion

- Mr. Rose noted that the Bush administration had removed funding for hydrogen production from renewable resources in the FY09 budget request. He asked how that decision will affect the 2012 targets for hydrogen production. Dr. Milliken commented that the current targets already have been bumped back as a result of budget shortfalls in 2004 through 2006, but they do not yet reflect the current 2009 budget of zero. The Senate budget mark-up for 2009 included $22 M for hydrogen production, so the program decided to wait for the final appropriation bill before modifying the targets.
- Because the DOE targets are partially based on EIA projections for the cost of gasoline, Dr. Shaw asked if the most recent EIA projections accounted for a potential cost of carbon in their calculations. Mr. Friedman pointed out that the EIA bases their forecasts on existing law, so there is no cost for carbon in their calculations.
- Dr. Ross voiced concern regarding DOE's 2008 cost status for an automotive fuel cell system ($73/kW). He believes that the high price of platinum would imply a much higher cost per kW, but more importantly, he argued that the volatility in prices of precious metals such as platinum makes cost based targets unrealistic and insufficient for use in program decision-making. Dr. Milliken explained that the DOE must assess its R&D progress, and it sets cost and performance targets relative to a benchmark. That benchmark for comparison is high-volume internal combustion engines. Therefore, the cost status for automotive fuel cells is modeled using state-of-the-art technology, including advanced membrane electrode assemblies and platinum loadings, at high-volume production (500,000 units per year). The platinum cost is also held constant (at $1,100/troy ounce) in order to separate the results of R&D from the price of platinum. Dr. Milliken noted that DOE's cost analysis, which is really a culmination of two analyses that are conducted each year by TIAX LLC and Directed Technologies, Incorporated (DTI), is currently being reviewed by an independent panel of experts. (She later mentioned that the cost analyses have undergone two other formal reviews by industry experts over the last five years, and the DOE gets feedback annually from the automotive industry on the methodology and assumptions used in the analyses.) She offered to send Dr. Ross the most recent TIAX and DTI analyses and the report of the independent review panel, and invited Dr. Ross to participate in future peer reviews or offer comments on how to improve the cost analysis.
- Mr. Rose pointed out that DOE's cost status is a projection that is a useful metric of progress, not a prediction about the future cost. Mr. Eggert noted that the DOE cost analysis process includes very detailed, bottoms-up costing for all the components of the stack, using advanced technologies that are being tested today. These analyses are extremely useful, he said, in pointing out where cost reductions are needed and in assessing the commercial viability of the technology.
- Dr. Shaw mentioned that there is always the possibility of non-platinum based catalysts, and expressed optimism for the inventiveness of small entrepreneurial companies. He noted he has seen legitimate plans for high-output systems utilizing no platinum, with costs as low as $20/kW.
- Dr. Schultz expressed concern regarding the $3/gasoline gallon equivalent cost of hydrogen delivery in the case of central hydrogen production. He believes the figure should be lower, given the low delivered cost for natural gas through pipelines. Dr. Milliken noted the figure is based on DOE's assessment of the current cost of pipeline delivery of hydrogen, and agreed to discuss the cost with Dr. Schultz in a separate discussion.

- Dr. Schultz asked if the DOE targets for hydrogen storage included efficiency (i.e., the round-trip energy efficiency of getting the hydrogen into and out of the storage media). Dr. Milliken replied her presentation only shows the "key" targets; there are a number of other targets for the storage system, including efficiency. She offered to provide Dr. Schultz with the full set of targets, and status estimates, for hydrogen storage. Dr. Carole Read (DOE-EERE, Hydrogen Storage Team) added that all of the storage targets, including gravimetric and volumetric capacity, are net usable capacity. So efficiency is inherently included in those targets as well as in a separate target for the energy efficiency of the system.
- Mr. van Dokkum urged the Committee to compare today's costs for manufactured fuel cells, hydrogen production systems, and hydrogen storage systems with the projected costs, and consider what kind of innovation is necessary to achieve those projected costs. He stressed that there are a lot of assumptions about technological advances in the projected costs, and a lot of work still needs to be done to develop those innovations. He feels it is important for the Committee to understand the relationship between today's actual costs and projected costs, and the work that needs to be done "before we start going into hefty commercialization discussions." Dr. Ogden agreed there are a lot of "caveats" built into the cost analysis that projects a fuel cell cost of $73/kW, particularly with regard to scaling up production volumes. She noted that these caveats are clearly presented in the reports, but maybe they should be communicated more generally so people understand them better. She also noted DOE has done some useful analysis of the scale-up process, in which costs are modeled at varying levels of production (from 10,000 to hundreds of thousands). Dr. Milliken stated that DOE is in the process of an independent assessment for fuel cell technology, and has completed one for hydrogen production from distributed natural gas.
- Mr. Eggert suggested the Committee examine the details of the cost analyses and provide input to the Secretary on where they think the cost estimates are "relatively certain versus more speculative." He suggested this analysis is an area where the HTAC can "potentially provide the most value because it's the most complicated to understand and the most misunderstood by the policy makers." He noted that many people disregard fuel cells as viable options when they hear numbers like $5,000 or $10,000/kW, but the reality is we can do much better than that. Dr. Milliken communicated that some members of industry have told DOE that the current low-volume cost is $3,000-$3,500/kW.
- Mr. Hofmeister added to Mr. Eggert's comments by noting that from a board room perspective, a company will ease slowly into a new technology. That is, major companies will "make bets on the future of hydrogen" that are predicated on their own analysis of the challenges and the potential for solutions that will allow commercialization. If this analysis is positive, they'll take "graduated steps forward." This path implies a readiness to take in the best information available today and to avoid getting "locked-in" on any one symbolic figure that can slow forward progress.
- Dr. McCormick commented that when a company considers whether to put a product into large-scale production, they examine every element along the supply chain from the raw materials to the manufacturing processes, and the partnerships that would be involved. The automotive industry has done this kind of in-depth, thorough analysis for fuel cells and is "much more optimistic" than some of the discussion today might indicate. He also noted that "enabling the supply chain" is critical for commercialization, and Japan and China are doing this much better than the U.S., by setting policies that enable growth of a supplier base.
- Finally, Dr. Rose commented that, as put forth in the National Academies study, it is not so much important to meet all the targets—what is important is to put together a car that is commercially competitive. The whole car is larger than the sum of its parts. He also offered a reminder that all the

alternative transportation energy options (Gen-2 biofuels, plug-in hybrids, etc.) face similar sets of challenges as hydrogen. All will require technical improvements and all will require substantial investments.

5. *Jobs in the Hydrogen and Fuel Cell Industry*

Mr. Don Jones, RCF Economic and Financial Consulting, Inc. and Mr. Joel Rinebold, Connecticut Center for Advanced Technology, Inc.

5.1 Energy Policy Act of 2005, SEC. 1820. Overall Employment in a Hydrogen Economy: Mr. Don Jones, RCF Economic and Financial Consulting, Inc.

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_feb09.html

One of the requirements of the Energy Policy Act of 2005 was to perform and publish a study of the likely effects of a transition to a hydrogen economy on the overall employment in the United States. Dr. Jones presented a briefing on the study, which was conducted by RCF with support from TIAX LLC, Argonne National Laboratory, Jack Faucett Associates, and an industry advisory panel. The report, *Effects of a Transition to a Hydrogen Economy on Employment in the United States Report to Congress*, was published in July 2008. The national employment impacts were estimated using the IMPLAN inter-industry model, and the DOE H2A models were used to characterize hydrogen production and delivery costs. The study considered the following issues:

- The replacement effects of new goods and services;
- The impact on international competition;
- The requirements for workforce training and education;
- Multiple fuel cycles (production pathways), including usage of raw materials;
- Different market penetration rates;
- Differences among regions.

The study measured the impact on employment by calculating the difference between a "non-hydrogen scenario" and two scenarios involving high and low market penetration rates of mobile and stationary fuel cells. The study found that a transition to a hydrogen economy would create between 360,000 and 674,000 new jobs (an increase in the total employment rate of between 0.20% and 0.37%) by 2050. Hydrogen technology commercialization would also reduce oil imports by between 6.6 and 11 M barrels of oil per day, at an import savings of between $230 B and $370 B per year. Please refer to the presentation for a detailed description of the findings and assumptions used in the modeling.

Questions, Answers, and Discussion

- Dr. Jones clarified that the input-output purchase coefficients used in the IMPLAN model reflected the different materials purchased to produce hydrogen fuel cell vehicles (as opposed to gasoline vehicles). The report itself details the employment impacts in specific industries.
- The job growth numbers in the lower New England and Mid Atlantic regions (which get about 20 to 25% of the jobs that will be created) should be brought to the attention of the politicians in those areas, per Chairman Walker.

- In response to a question from Dr. Schultz, Dr. Jones explained, "to produce the hydrogen vehicles and produce the hydrogen and make the investments in infrastructure required to produce that hydrogen…it's going to take 675,000 *additional* people. Most of them will be employed in the same [kind of] industries that presently produce gasoline-powered vehicles." Therefore, these are new jobs beyond the jobs that would be retained within the automotive industry and its supply chain. To establish this figure, RCF worked with an industry advisory panel and other survey participants to establish what new skills would be needed in a hydrogen economy that were not currently used in producing gasoline vehicles. Mr. Eggert continued the questioning and asked how many jobs are created by reducing the amount of oil that is imported and producing more fuel domestically? Dr. Jones replied that the model was not designed to answer that question, although the study did find a reduced number of jobs in refineries and domestic production operations.
- Dr. Jones explained that the study used the H2A model for the costs of dispensing hydrogen, but he was not sure whether the H2A model assumes self-service or attendant service at the hydrogen fueling station. With regard to including costs and jobs for constructing and permitting hydrogen fueling infrastructure, he explained that the RCF team estimated the installation cost for equipment and labor and allocated the cost across the sectors from which those inputs would be purchased. They did not have time in this study (which was conducted over a 3-month schedule) to consider the employment impacts of permitting, but he assumed that even if permitting requirements were relatively high in the early years, they would probably diminish over the years as the process gets routinized.
- No sensitivity analysis on the cost of hydrogen or fuel cell vehicles has yet been performed.
- Mr. van Dokkum observed that this transition could potentially create 675,000 new jobs and save $370 billion annually in outflows for foreign oil, compared to spending close to $800 B in the stimulus bill to create four million jobs.
- Mr. Chernoby suggested that the Committee may want to look at some of the study's assumptions in more detail before they "run with the numbers." For example, he believes fewer people will be required to build a fuel cell vehicle since they are less complicated than internal combustion engines.
- Dr. Milliken pointed out that EERE is currently developing a consistent methodology and set of assumptions for job studies so their results can be transparent, credible, and easily compared. She noted that the RCF study had a very short schedule due to the EPACT deadline for the report to Congress, and that "we can probably do a better job as we move forward on EERE jobs analysis."

5.2 "Green" Jobs in the Hydrogen Industry: Mr. Joel Rinebold, Connecticut Center for Advanced Technology, Inc.

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_feb09.html

Mr. Rinebold presented on a study by the Connecticut Center for Advanced Technology (CCAT) on the state of the hydrogen and fuel cell industry in Connecticut and how it contributes to the creation of "green jobs." The "industry" in Connecticut includes developers and manufacturers of large stationary fuel cells, polymer electrolyte membrane fuel cells, and hydrogen production units (electrolyzers and membrane reformers) as well as fuel cell R&D labs at University of Connecticut and other institutions. The presentation topics included:

- Drivers for hydrogen and fuel cell market growth

- Growth of the fuel cell industry in Connecticut
- Direct and indirect industry employment in Connecticut (2006, 2007, and estimated in 2010)
- Economic multipliers of hydrogen and fuel cell jobs
- Assessment of the size of "mature" global distributed power generation and transportation markets
- The impact of quadrupling production capacity (from 10MW to 40MW per year) on reducing production costs (from $3,200/kW to about $2,000/kW)
- Opportunities for further development of the Connecticut supply chain
- Relationship between the current level of annual fuel cell production capacity in Connecticut (10 MW) and jobs, gross state product, and annual tax revenues; and how these would grow if the state were to support "block purchases" of fuel cells that would increase the industry's annual production capacity to 50MW. The study's findings included:
    - A relationship of 240 jobs per MW exists; production of 50 MW would involve approximately 12,000 jobs.
    - A relationship of $34 million of gross state product exists per MW; approximately $1.7 billion of gross product would be generated for an output of 50 MW.
    - A relationship of $3,100,000 of state and local tax revenue exists per MW; approximately $155 million of state and local tax revenue would be generated with an output of 50 MW.
    - Government investment in a block of fuel cell capacity would create "green jobs" while simultaneously producing needed "green energy" to both stimulate the economy and protect the environment.
    - Timing to move forward with an investment initiative is appropriate to capture early markets for future global market penetration.

Questions, Answers, and Discussion

- DOE has not conducted a state-by-state analysis of employment impacts. Dr. Milliken stated that one of the reasons they asked Mr. Rinebold to present is that Connecticut is the only state DOE knows of that has done this type of analysis. Chairman Walker remarked that the Obama Administration is focused on job creation, and particularly on green jobs, and therefore having reliable data on job projections would be very useful. He asked whether DOE was planning to collect this type of state-level data in their "new jobs study." Dr. Milliken responded that the effort to develop a consistent methodology for DOE jobs analysis has only just begun, and there is no plan or timeline yet in place for any particular studies.
- Dr. Ogden questioned the assumption that jobs will scale linearly with the MW capacity output. For instance, the number of R&D jobs would likely not continue to increase linearly at higher output levels. Mr. Rinebold agreed and said he and the industry reviewers of the study are comfortable with linear scaling to around 100 or 200 MW. After reaching a larger scale, there will be efficiencies gained in manufacturing and other areas that would reduce the number of jobs per MW.
- Dr. Ross asked whether the Canadian government had performed a similar jobs analysis for its fuel cell industry. No one knew of one, but DOE agreed to look into it.
- Dr. Schultz wondered why Connecticut only calculated 1.31 indirect jobs created for each direct job. He has seen analysis that places this multiplier at about seven, "including the grocer, the pizza

delivery person, and so forth." Mr. Rinebold admitted his analysis was intentionally conservative, and he has seen studies that use higher multipliers for both indirect and "induced" jobs.

- Mr. Rinebold noted that the state of Connecticut has a "7,000 MW capacity demand with about a 100 MW per year need for new capacity, assuming business-as-usual; with retirement of old units, that number could double. The study thus suggests the state of Connecticut could help support the installation of 50 MW of fuel cell capacity each year from local manufacturers. Mr. Hofmeister wondered whether "not-in-my-backyard" (NIMBY) opponents of energy infrastructure development would prevent or delay that from happening. Mr. Rinebold explained the industry has received good grassroots support, due in part to proactive outreach activities. The outreach efforts to the public, fire marshals, building code officials, and others have "tested local sensitivity to this issue and we have gotten nothing but favorable remarks. He noted that one of the messages that resonates is that this investment can create positive returns for the state while avoiding a "truly difficult NIMBY facility—high voltage transmission lines."
- Mr. Chernoby asked what it would cost the state to support this 50 MW of additional production capacity. Mr. Rinebold noted that the business case for fuel cells is strongest when you can use the heat and where the electric rates are high. These types of installations can sometimes break even with just the Federal investment tax credit. In situations where combined heat and power (CHP) is not possible, then additional state subsidies may be needed. For a state subsidy level of $2,000/kW, that would be equal to spending $100 million for 50 MW of capacity that would, according to the CCAT study, generate $155 million of state and local tax revenues (in addition to creating sustainable jobs; providing reliable, distributed heat and power; and cutting carbon emissions).

6. *Draft and Discussion on HTAC Annual Report*

Vice Chairman Shaw presented an overview of the HTAC's Policy and Planning Committee (PPC) activities over the last year, including the effort to develop the "HTAC Annual Report on the State of Hydrogen and Fuel Cell Technology Development and Commercialization." The highlights of his summary are provided below.

- Activities completed over the last year by the PPC and discussed and approved by the full HTAC:
  - HTAC Vision Statement
  - "Talking points" paper for the Secretary (which includes the vision statement and which has been printed as a handout for public distribution and posted to the HTAC website; copies are available from DOE.)
- At the December 2007 HTAC meeting, the idea of an annual report summarizing the "state of hydrogen technology" was first suggested. This document would later come to be known as the "Annual Report," although Dr. Shaw stressed this report does not replace the HTAC's report to the Secretary with recommendations for the Hydrogen Program. The idea of a Hydrogen Progress Index was also proposed. Later, the idea of an "Index" was tabled due to the difficulty in developing a meaningful metric.
- The HTAC agreed that the Annual Report would be a short document in a bulleted style, focused on important national and international accomplishments in hydrogen and fuel cells technology development and commercialization (or setbacks) over the year. Assuming the first year (2008) effort is successful, the HTAC agreed to develop the report annually, at the end of each year.

- Following extensive discussion of the content for the Annual Report at the November 2008 HTAC meeting, a first draft of the Annual Report was prepared by the PPC in December 2008. The document went through three revisions. The third draft was sent to the full HTAC for review on January 23, 2009, and is the subject of today's discussion. Comments received to date from HTAC members were compiled and provided in the HTAC briefing materials.
- Several members suggested in their comments on the January 23 draft that the Annual Report be transmitted to the Secretary with a cover letter from the HTAC Chairman that is "contextual" and "topical," and focuses more on what "needs to be done" to keep the Hydrogen Program moving forward.

Discussion

The HTAC agreed to continue forward with the current format of the Annual Report and a one- to two-page cover letter to Secretary Chu. Chairman Walker volunteered to draft the cover letter, which would be signed by himself and Vice Chairman Shaw. The discussion continued with detailed review and comment on the January 23, 2009 draft of the Annual Report, the highlights of which are summarized below.

- Chairman Walker suggested reordering the Annual Report based on his discussion with Secretary Chu about the importance of near term work on stationary fuel cells and his interest in energy storage. Consequently, the Committee agreed the "Commercial and Demonstration Activity," including separate sub-sections on stationary fuel cells, energy storage, and "other mobile applications," should come before the section on "Technology Developments." The new sub-section on stationary fuel cells will include relevant bullets from the sub-section currently titled "Other Fuel Cell Applications," and will be expanded and strengthened as the lead section for the document (e.g., to include U.S. installations of back-up power at critical load facilities, activity in Japan on residential CHP, and, if available, total number of stationary fuel cells deployed worldwide). The new sub-section on energy storage will include bullets addressing 1) the potential competitiveness of hydrogen energy storage systems with combustion turbine peaking power, 2) the Wind2H2 project, which is exploring hydrogen energy storage as a means of enabling intermittent wind and solar power, and 3) any relevant international accomplishments. Mr. Rose will provide an additional bullet for the "Other Mobile Applications" sub-section, on the use of solid oxide fuel cells in auxiliary power units; this section will also include a bullet on the fuel cell powered passenger ship in Germany.
- Dr. Milliken suggested the Committee may want to also address the Secretary and Mr. Beaudry-Losique's interest in learning more about the challenges and cost of hydrogen fueling infrastructure and in where to put funding resources. To address this topic, the cover letter will reference the National Academies of Sciences (NAS) report's findings. Also, the Annual Report section "Hydrogen Fueling Stations" will be re-named "Hydrogen Infrastructure" and will cite the actual costs for infrastructure development estimated in the NAS and Oak Ridge National Lab studies.
- Mr. Eggert suggested including references for all of the "technical claims" in the document. After some discussion on these references, it was generally agreed that the Annual Report was not being presented as a "technical" document, and including all the references would make the report too long. It was suggested that the HTAC keep track of the references in a separate document in the event the Secretary wanted to know the primary source. It was also proposed that the HTAC create a page on its website to list and provide links to what they consider as "the best available technical documents."

- After some discussion about whether to include specific HTAC recommendations (regarding funding levels, program priorities, and/or policy directions, etc.) in the Annual Report, the Committee agreed the Annual Report will focus on presenting "a summary of what happened" over the past year. HTAC will prepare a separate report to the Secretary later in the year that will include recommendations, in its "advisory" role per the Energy Policy Act of 2005 (EPACT). Ms. Epping Martin reminded the Committee that they can send inputs or reports to the Secretary whenever they like. The Secretary will respond, in his biennial report to Congress, to all the feedback his office has received since the last report to Congress. [Note for clarification: EPACT Section 807 does not specify any regular report (or reporting period) for the HTAC itself. However, Section 807 requires that the Secretary *"shall transmit a biennial report to Congress describing any recommendations made by the Technical Advisory Committee since the previous report. The report shall include a description of how the Secretary has implemented or plans to implement the recommendations, or an explanation of the reasons that a recommendation will not be implemented."*]
- After lengthy discussion on the pros and cons of including a specific figure on the current cost of automotive fuel cells, the Committee agreed to include DOE's 2008 ***modeled*** cost status of $73/kW, *as projected for a manufacturing volume of 500,000 units per year* in the Technology Development/Fuel Cells section.
    - Dr. Milliken suggested it might be useful to bring the representatives from TIAX LLC and Directed Technologies, Incorporated (who performed the projected cost analyses) to a future HTAC meeting to brief the Committee on the methodology and assumptions used in developing the DOE fuel cost analysis. The Chair and Vice Chair agreed this topic would be a good agenda item for a future meeting.
- HTAC support staff will edit the introductory paragraph to address issues with grammar, sentence structure, and use of passive voice.
    - First sentence should convey what differentiates hydrogen from other alternatives: its ability, in combination with the green grid, to achieve major greenhouse gas reduction goals. Mr. Hofmeister suggested the following language: "Fuel cells continue to offer one of the most promising, *sustainable and carbon-friendly* pathways for our nation to achieve…"
- Emphasize in the cover letter and/or report the fact that some hydrogen and fuel technologies are ready now for commercial deployment, and fuel cell vehicles are moving "beyond [demonstrations in] fleet applications behind the fence."
- Other suggestions for the cover letter included:
    - Address three things: 1) HTAC is eager to help the new administration, 2) potential for green jobs with hydrogen, and 3) a caution on mounting competition and the opportunity for the U.S. to take a leadership role on commercialization. (Hofmeister)
    - Include the recommendation that the "resources of the [Recovery Act] should be utilized to begin implementation of the NAS study." (Walker)
    - Include paragraph explaining that, despite the progress in 2008, there are continuing issues "that must be addressed through research and development and financial risk mitigation with substantial federal intervention." The NAS study provided "the nation with a roadmap for addressing these issues," so the HTAC urges the department to "follow the science" and implement that roadmap. (Walker)

    - Convey the idea that "managing risk is the silver bullet" – we do not know yet what the "right" answer is, so we need to be investing now in a variety of technologies, including hydrogen and fuel cells. (Friedman)
- The Committee agreed the Annual Report and cover letter should be provided to the Secretary as soon as possible, so it will follow closely on Chairman Walker's meeting with him. Congressman Walker will draft the cover letter and provide that to the HTAC for review tomorrow (February 19). The Chair, Vice Chair and HTAC support staff will incorporate the HTAC comments from the February 18-19 meeting to produce the final drafts. The final draft report and cover letter will be sent to the HTAC for review (via email, for major errors or omissions only), with the goal of getting the final, signed package to DOE for delivery to the Secretary by mid-March.

As previously mentioned, the Committee ultimately decided not to include any specific recommendations in the Annual Report itself. However, over the course of the discussion a number of recommendations or comments for later consideration were suggested by members, as summarized below.

- DOE should restore the applied research program funding for renewable hydrogen generation. (Rose)
- DOE should actively use the authority it already has (through EPACT) to facilitate the purchase of fuel cells by federal agencies. (Rose)
- Deployment of hydrogen infrastructure is not just important for / useful to passenger vehicles. It is also important for commercial proliferation of near-term stationary applications and material handling equipment. (Rose)
- The government needs to take seriously the recommendations of the NAS study and begin the process of providing the necessary incentive or buy-down programs for hydrogen infrastructure and vehicles. Show the government cost for supporting the incentives in time segments, so the administration can see what it would cost over the next three years. (Shaw, Hofmeister)
    - The "silver bullet" that could "change overnight the business case analysis for fuel cell vehicles" would be for government to announce a program to buy down the early-production cost differential so that the automotive industry is not risking so much capital. This type of program has worked in Germany (using a feed-in tariff incentive program) to jump-start commercial installation of wind and solar power. (McCormick)
    - "Managing risk is the silver bullet […] the reality is that we need to start making investments now in a whole variety of areas to start mitigating risk in the long term." (Friedman)
    - Industry must have a "high degree of certainty that the sale's actually going to happen and that you're going to get a return." (Chernoby)
- Discuss what steps should/can be taken over the next 3 years, as well as over the longer term (referencing the NAS study, GM and Shell infrastructure study, and California studies). (Eggert, Ogden)
- Bus fleets, postal service fleets, commercial delivery fleets, etc. can be launched right away to begin building the vehicle and fueling infrastructure. (Shaw, Chernoby)
- Fleets may be useful as "anchors" in the early years, but ultimately the OEMs want to place vehicles and fueling infrastructure with typical consumers in focused geographic areas as a way to move towards the "prize of markets where you can make hundreds of thousands of [FCVs] per year." (Ogden)

- Review the Recovery Act in detail and make recommendations with regard to 1) how that funding could be used to support building hydrogen infrastructure and installation of stationary, mobile, or portable power fuel cells and 2) what more is needed beyond those funding initiatives. (van Dokkum)
    - With regard to this suggestion, Mr. Hofmeister proposed holding a "special HTAC meeting" in the next 30-45 days to review a detailed analysis of what is in the Recovery Act to develop these recommendations. Mr. Rose suggested that the decisions on how to allocate the funding will likely have already been made by then, if they haven't been made already.
- Clarify what the gaps are (what remains to be done) and what goals have more or less risk associated with them. (Taylor)
- Clarify that hydrogen and fuel cells is a "family of technologies and not all the family members are at the same point in their commercial progress." Like all new technologies, first cost is a continuing challenge and one where Federal partnership can be of real assistance. (Rose)
- Address the Secretary's concerns about the cost or viability of building out a hydrogen fueling infrastructure. (Hofmeister)

The February 18, 2009 HTAC meeting was adjourned at 5:30 pm.

February 19, 2009

Chairman Walker called the meeting to order at 9:00 a.m.

1. *Public Comment Period*

The Department of Energy (DOE) reported that no one had pre-registered to make public comments before the Committee. Chairman Walker opened the floor for public comments. Hearing none, the public comment period was closed.

2. *Hydrogen Policy Analysis by Argus Research*

Mr. Kevin Tynan, Argus Research

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_feb09.html

Mr. Tynan is the Senior Automotive Analyst at Argus Research, an independent investment research firm. He focuses on identifying equity investment opportunities in the near-, mid-, and long-term in the automotive arena. Mr. Tynan presented results of his recent analysis, from an investor perspective, of next generation automotive technologies.

The topics covered in the presentation included:

- Drivers for alternative fuel vehicles:
    - Financial impacts of U.S. dependence on foreign oil
    - Greenhouse gas concerns with continued oil use
    - Caveat that although these are big problems from a national perspective, what really drives vehicle sales is consumer purchasing decisions, and according to his analysis, the typical consumer will not voluntarily pay more for a vehicle or sacrifice freedom of mobility to address societal problems.
- Three scenarios for market penetration of plug-in hybrid vehicles (PHEVs) and gas/electric hybrids, with projections for annual outflow of money for foreign oil under slow, medium, and aggressive penetration of PHEVs. Conclusions:
    - Even the most intense adoption of PHEVs and gas/electric hybrids will fail to solve U.S. dependence on foreign oil (and associated annual outflows of money) or reduce green house gas (GHG) emissions.
    - The only complete long-term solution for eliminating dependence on foreign oil and GHG emissions from passenger vehicles is a move to hydrogen.
    - Domestic automakers must pursue technologies that will give them a competitive advantage: *early commitment* to the technology that offers the most complete solution (hydrogen vehicles) will provide a meaningful competitive advantage.
    - *All* the different alternative vehicles will face the same challenges in gaining market share, so why not pursue the technology that will provide the greatest social benefits?
- Vehicle dealerships as promising locations for early hydrogen infrastructure (the HTAC noted that the same idea is proposed in the recent National Academy of Sciences report on the hydrogen transition).

- Consumer and corporate (automotive company) drivers for vehicle demand and supply
- Reasons for HEV "failure" to "change the buying habits of consumers" and gain market share at a faster pace
- Lessons learned: how to create demand for hydrogen vehicles
    - Many consumers want to (or will only) buy domestic – U.S. automakers need to be in the game.
    - Consumers will not pay premiums—incentives are needed to buy down the costs
    - Provide models in all vehicle size ranges.
    - Differentiate the vehicles by providing unique features that take advantage of the electric drive train.

Questions, Answers, and Discussion

- The scenario analysis presented by Mr. Tynan projected more ICEs in the aggressive PHEV penetration scenario (40% of the light-duty fleet) than in the moderate scenario (37%). Mr. Tynan explained this projection is because the aggressive scenario "leap-frogs" gas/electric hybrids, but it takes longer for this to happen. Every year that penetration of PHEVs is delayed, more ICEs are selling into the fleet (which grows along with population). He noted the number of ICEs drops off more steeply after 2040 in the aggressive scenario.
- Mr. Tynan explained that the projected annual spending outflows for oil do not necessarily track directly with an increase in PHEVs or with a reduction in ICEs, since the price of oil changes with time, and is different in each scenario.
- Mr. Friedman questioned the presentation's statement that hybridization only leads to a 24% improvement in fuel efficiency. Mr. Tynan explained this assessment is based on a comparison between a hybrid and its direct ICE analogue (the Toyota Prius does not have a non-hybrid analogue, so it is not included in the assessment). Dr. McCormick added that some of the efficiency improvement in the hybrid vehicle "package" comes from features other than the hybridization of the engine (e.g., light-weighting, lowering resistance, etc.), and agreed that the estimate of 24% efficiency improvement was "a pretty good number." Mr. Friedman disagreed, and pointed out that there are many studies of hybrid vs. ICE fuel economy that subtract out the features Dr. McCormick mentioned. He asserted that for a full hybrid with a down-sized engine, a 40% improvement in fuel efficiency is more reasonable.
- Dr. Shaw pointed out that there will be a price premium, at least initially, for HFCVs. Mr. Tynan agreed, but noted that his analysis indicates that there will be a price premium for any alternative fuel vehicles, so, in his opinion, the nation should pursue the technology option that "offers the most complete solution" to foreign oil dependency and greenhouse gas emission reduction. Chairman Walker suggested that the benefits of an electric drive train (safety, electronic steering, electronic braking, etc.) offer additional selling points for HFCVs, for which customers may be willing to pay.
- Mr. Eggert warned against expressing the hybrid vehicle adoption rate as a "failure." He suggested a major change in drive trains could take 30-40 years for a complete transition, and HFCVs will face some of the same challenges as hybrid drive trains (e.g., manufacturers wanting to avoid warranty risks, slow development of the supply chain, etc.).
- Dr. Ogden described work by colleagues at U.C. Davis, which investigated underlying values and why hybrid owners actually bought hybrids. They discovered that hybrid owners purchased their

vehicles for a few reasons: 1) they are technology early adopters, 2) they want to save oil (and money on fuel), 3) they like the quiet operation of a battery, and 4) they have green values. She noted that hybrid vehicles have deployed faster in some regions than others. Chairman Walker added that the ability for hybrid vehicle drivers to use high-occupancy vehicle (HOV) lanes is also a motivator for purchasers. Mr. Tynan agreed, adding that a large part of domestic auto marketing is geared towards "fashion," and in some areas hybrid vehicles are fashionable. However, he pointed out that hybrid sales currently account for only 2.37% of new vehicle sales after 10 years.

- Dr. Ogden wondered whether this was an era of changing values, as can be seen from recent moves to increase CAFE standards and mounting calls for carbon policy. She urged Mr. Tynan to include "the underlying policy landscape" as a factor in his future analyses. He agreed that it is difficult to remove government from this discussion.
- Mr. Hofmeister observed that Mr. Tynan's analysis assumes a flat or decreasing domestic oil/liquid fuels production. He challenged that assumption with a projection that there will be a large increase in liquid biofuels production over the same time period (up to a 20% addition to our liquid fuel base). He also noted that the U.S. has abundant domestic oil reserves, offshore and otherwise, that are not currently open for development. He foresees that increasing oil price pressures, coupled with growing state and national budget deficits, could convince lawmakers and the voting public to open up these reserves for oil production. While he personally agrees that a "leap-frog" to new vehicle technology is needed, he sees that an additional deterrent will be the "tension that the liquid fuel producers will create to sustain the internal combustion engine."
- Dr. Schultz made a reference to a speech by Larry Burns, GM Vice President of Research & Development and Strategic Planning, in which Mr. Burns described the benefits of fuel cell vehicles to both automakers and consumers. The simplification of the fuel cell vehicle drive train can ultimately lower vehicle manufacturing costs while the greatly increased fuel economy lowers operating costs for consumers. Dr. Schultz added that gasoline prices play a big part in this equation, so one way to encourage investment in HFCVs would be to "encourage gasoline prices that encourage the investment." Mr. van Dokkum agreed that there is consensus in the auto industry that the cost of producing and maintaining a fuel cell vehicle will be much lower than a hybrid vehicle. Dr. Lloyd foresees that the increase in CAFE standards will result in the hybridization of all vehicles, including heavy-duty trucks, which will narrow the price differential between HFCVs and other vehicle alternatives.
- Dr. Lloyd reminded the Committee that two of the "Big 3" automakers have recently "made the decision to opt out of hydrogen fuel cell vehicles," so Mr. Tynan's suggestion that the Big 3 should move aggressively on this technology to capture competitive advantage may already be unlikely.
- Mr. Friedman pointed out that Mr. Tynan's analysis may "under-sell" the benefits of reducing oil use. He noted that while reducing oil imports (and associated monetary outflows) is extremely important, reducing the amount spent on domestic oil production "could shift money from spending on oil to spending on other products that are going to create more jobs, create more GDP, and so forth." In addition, he said, demand reduction could lower oil prices even further in that future market.
- Dr. McCormick stressed the need for "consistent government policies and ground rules" so auto companies can focus on deploying a smaller number of new technologies. Compared with taking a new vehicle to mass production, research is relatively inexpensive and automakers routinely pursue R&D to develop a "portfolio of options." Private companies cannot manufacture and market all of these new vehicles at the same time. They have to choose which option(s) to pursue at any given time based on an assessment of market penetration, return on investment, etc., which is influenced by

state and federal government policies. As an analogy for the decision-making process, he asked if any of the Committee members would be willing, with the policies in place now, to "bet their house" on Tesla Motors (makers of an all-electric vehicle), because that is what the automakers are essentially asked to do – choose an option and bet the company on it.

- Mr. Hofmeister agreed with Dr. McCormick and continued the idea to infrastructure—he asserted that it is impractical to think that multiple fueling infrastructures (e.g., biofuels, compressed natural gas, gasoline, hydrogen) can be supported on a single retail plot of land, especially given the tight profit margins under which the retail fuel business operates. With regard to the notion that auto dealerships might provide good locations for early hydrogen fueling, he noted that "the retail fueling business is really a real estate business," and that dealership locations are not generally convenient to most consumers as they commute or travel interstate highways. He declared that the "the big decision that has to be taken by our society and our government…is that the incentives for [vehicle] technology and the incentives for fueling infrastructure are simultaneous and they're big enough and strong enough that we're not [squandering] a lot of good value for the sake of some politically-correct ideas that some advocates and special interests are pushing."
- Mr. van Dokkum stated that automakers recognize the value proposition for moving towards a fuel cell vehicle, and that the hybrid vehicle is one step along that path. However, he agreed that the market is "confused" because there are a lot of options and different pressures for short term versus long term. He urged the Committee to "keep the long-term vision in mind, that fuel cell vehicles indeed can be a much more cost-effective platform and we need to focus our efforts on that because, ultimately, one platform will win."
- Dr. Shaw thanked Mr. Tynan for presenting and urged him to continue communicating and advocating the real potential of hydrogen and fuel cells to the investment community. He echoed Mr. van Dokkum's point that the hydrogen fuel cell vehicle platform will likely emerge as the eventual winner, but noted that the Committee agrees that policies will be needed to make the transition.

3. *Progress in Low-Pt / No-Pt Catalysts*

Dr. Debbie Myers, Argonne National Laboratory (Speaker) and Dr. Philip Ross, Laurence Berkeley National Laboratory (Facilitator)

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_feb09.html

Dr. Myers extensively outlined the current status of catalysts in polymer electrolyte membrane (PEM) fuels cells, from more traditional platinum-based to novel non-platinum catalysts. The topics covered in the presentation included:

- Basics of catalyst action in a PEM fuel cell
- Durability and cost challenges for platinum- or palladium-based catalysts
- Department of Energy catalyst technical targets
- Various approaches being pursued for developing lower cost and more durable PEM catalysts
    - Platinum group metal (PGM) alloys – the alloying elements are typically nickel, iron or cobalt, which are much lower cost than platinum or palladium, and the alloys can also enhance the electronic properties and bonding properties of the PGM.
    - Ultra-low platinum loading by "nano-engineering" of particles, in which a thin film of platinum is placed on top of the existing particle (termed the "core shell structure") where the

interior of the particle not only replaces platinum with something less expensive but also enhances activity of platinum on the surface.

- Novel support and catalyst structures, in which the PGM catalyst is incorporated into a structured support that increases its activity, such as organic "whiskers," carbon nanotubes, mesoporous carbon supports, and conductive oxide supports
- Non-PGM catalysts, in which the platinum or palladium is completely replaced with other metals (e.g., iron and cobalt complexed with carbon-nitrogen molecules/polymers; chalcogenides; and carbides, oxides, oxynitrides and oxycarbonitrides).

Recent scientific results for each catalyst approach were presented by Dr. Myers to give the Committee a better understanding of the status and potential of the different technologies. Finally, she outlined DOE's catalyst R&D strategy to address cost and durability issues: continue researching the different catalyst options in parallel; increase open circuit voltage and performance of non-PGM catalysts; identify and mitigate catalyst degradation mechanisms; test catalysts under load cycling and start stop conditions; and develop an accelerated test protocol to mimic real-world conditions while shortening testing time. Dr. Myers acknowledged contributors to her presentation, including Fred Wager (General Motors), Jim Waldecker (Ford), Nancy Garland (DOE), and John Kopasz (Argonne National Laboratory), and the various catalyst material researchers around the world who were cited in the presentation.

Questions, Answers, and Discussion

- Dr. McCormick thanked Dr. Myers for an excellent presentation on research progress. He noted that automakers have developed "system mitigation strategies" for dealing with various operating challenges in the near term, but the ultimate goal for researchers is to "solve the problems straight up." The business goal is to manufacture the simplest, lowest cost system possible, which does not require these engineering "work-arounds." He stressed the need for research, including theoretical research to understand fundamentals, to solve the underlying problems. Dr. McCormick also expressed a caution that materials tested in the lab can be altered in the manufacturing process (e.g., by the introduction of a contaminant), so this needs to be considered when considering the true potential of a catalyst material.
- Mr. Eggert echoed Dr. McCormick's appreciation for the presentation, stating that he was "even more optimistic than [he] was yesterday on the potential for the costs of these systems." In response to his questions about the cost calculations, Dr. Myers pointed out that the current DOE target for platinum cost, shown in the target table on slide 4, is based on 2002 dollars, with a platinum (Pt) cost of $450/troy ounce (equal to $15/gram with a Pt loading <0.2 gram Pt per kilowatt (kW)) and cost projected to high volume production (500,000 stacks per year). The 2008 cost status figure of $73/kW was developed in an annual cost analysis effort (performed by TIAX LLC and Directed Technologies Incorporated for DOE). Dr. Milliken explained that DOE decided to use a constant cost for Pt of $1,100/troy ounce in its cost status analysis, in order to separate the results of research progress from the fluctuating cost of Pt. The DOE cost analysis in 2008 was performed with a total Pt loading of 0.25 milligrams of platinum per centimeter squared (mgPt/cm2), which Dr. McCormick agreed was a reasonable number.
- Mr. Eggert asked whether a systems cost analysis has been performed for the novel catalyst approaches such as core-shell structures, nano-structured thin films, or non-PGM catalysts. Dr. Myers replied that the costs she showed for these novel approaches are purely based on the Pt cost and the reduction in loading that is enabled by having core shell structures and improved activity of

the platinum. Mr. Eggert said it would be extremely valuable to have an analysis that compares the different catalyst approaches on a common cost basis, and Dr. Milliken replied that she thought this was something DOE can do.

- Dr. Ross disagreed that cost should be used as a metric for measuring progress, because of the volatility in Pt price and the uncertainty around its availability. He suggested that the metric for fuel cell catalyst progress should be total platinum loading – getting the desired performance from the fuel cell with the minimum Pt loading. Dr. Meyers referred Dr. Ross to a 2003 study conducted by TIAX LLC, "Platinum Availability and Economics for PEMFC Commercialization," for a more detailed treatment of the effect of fuel cell vehicle introduction on the cost and availability of platinum.
- Dr. McCormick reminded the Committee that today's gasoline and diesel internal combustion engine (ICE) vehicles have catalytic converters that contain a platinum catalyst. The goal, he said, should be to reduce the amount of platinum in a fuel cell vehicle to below that of an advanced ICE or hybrid-ICE vehicle.
- Theoretical research efforts on catalysts and the mechanisms of catalyst action are very active, according to Dr. Myers. Dr. Milliken added that Dr. Myers only presented the applied research that is ongoing; DOE's Office of Basic Energy Science (BES) is also part of the Hydrogen program, and BES has a fundamental research area that includes catalyst theory and modeling.
- Dr. Hicks noted that "one of the nice things about platinum is it's not toxic, and Congress is very concerned about environmental health and safety of nanoparticles." She asked whether the field is considering the toxicity effects of the catalysts or solvents used in manufacturing. Dr. Myers explained that work is underway exploring the use of aqueous-based solvents in manufacturing the electrode layers. Dr. McCormick and Mr. van Dokkum added that industry focuses on both safe manufacture and recyclability as part of its commercialization decision process. Dr. Myers also noted that DOE has research projects on fuel cell materials recycling.
- In response to a question from Dr. Ogden about water management issues with the 3M nano-structured thin film (NSTF) catalyst, Dr. Meyers replied that 3M has "gone to very low relative humidities with inlet gases [which] typically tends to degrade the membrane…But they have developed an improved membrane to go along with their improved catalyst layers that can tolerate these lower relative humidities. The greater than 7,000 hour lifetime [reported by 3M] was actually achieved with their improved membrane and the NSTF catalyst."
- Dr. Lloyd asked whether any of the catalysts being investigated were more or less resistant to poisoning from sulfur in the ambient air. Dr. Myers explained that the metal-based catalysts, including the platinum-based and palladium-based catalysts, are very susceptible to sulfur poisoning. The pyrolized-type iron-cobalt materials and oxide-based catalysts are less susceptible. GM has placed fuel cell vehicles on the road in China, where high-sulfur diesel fuels are still used, to better understand the affect that sulfur poisoning may have on their fuel cells.
- Asked by Mr. Chernoby about the energy-intensity of making platinum alloys, Dr. Meyers replied that making a platinum alloy catalyst requires a higher temperature and would require more energy to make than a platinum-only catalyst.
- Mr. van Dokkum and Dr. McCormick pointed out that the kinds of considerations raised by the Committee (toxicity, safety of manufacture, recyclability, raw materials cost and availability, energy intensity, etc.) are all part of the commercialization decision process. Companies employ groups whose job it is to evaluate the commercial feasibility of materials and technologies that are in the research stage. Research that is not likely to make it to market is eventually discontinued.

- Dr. Shaw disputed the analysis which showed a high projected cost for Acal Energy's liquid re-circulating oxidant, polyoxometallate. Dr. Shaw and Dr. Myers will exchange information and discuss off-line.

4. ***Investment Tax Credit***

Mr. Lee Peterson, Reznick Group and Mr. Sam Logan, Logan Energy, Inc.

>> see full presentation at http://www.hydrogen.energy.gov/htac_meeting_feb09.html

4.1 Fuel Cell Tax Incentives: How Monetization Lowers the Government Outlay: Mr. Lee J. Peterson, Esq., Reznick Group, P.C.

Mr. Peterson, Senior Tax Manager – Energy Tax Credit Consulting with Reznick Group, P.C., briefed the Committee on the applications and benefits of fuel cell tax incentives defined in the U.S. tax code. He briefly discussed the difference between a Production Tax Credit (PTC) and an Investment Tax Credit (ITC), though generally focused on the advantages of the ITC. Tax credits provide powerful incentive for investment, and the ITC tends to be better suited to fuel cell systems than the PTC; however, there are many complicated issues involved, and the tax advantages must, therefore, be implemented correctly. Questions were held until after Mr. Logan's presentation on a case study of using the ITC to help finance a DOD fuel cell project.

The topics covered by Mr. Peterson's presentation included:

- Eligibility for and size of credits under the PTC and the ITC
- Possibility of taking ITCs for both combined heat and power (CHP) and fuel cells if used together in the same system (current assumption is you cannot take both; you must take one ITC or the other)
- How monetization of tax credits can reduce government program outlays
- A comparison to the successful Low-Income Housing Tax Credit which stimulated investment in rental property for low-income residents
- Comparison of the old ITC fuel cell credit with the newly revised version
- Comparison of the pros and cons of monetizing tax credits versus direct government grants
- Two detailed, though simplified, examples demonstrating the savings offered by the revised ITC
- Discussion of property that qualifies for the ITC under government and tax-exempt "use" rules
- California's Self-Generation Incentive Program (SGIP)
- Service contracts can be structured to avoid provisions that would disqualify the property from receiving ITC benefits.

4.2 ITC Role in US Fuel Cell Projects – Case Study with a DOD Facility: Mr. Samuel Logan – Logan Energy

Mr. Logan presented a case study of a Department of Defense (DOD) fuel cell project that utilized the ITC. His company installed a 750kW capacity CHP molten carbonate fuel cell (MCFC) system at Camp Pendleton under contract with the Naval Air Weapons Division, China Lake. By utilizing the ITC and California's SGIP, Mr. Logan was able to make the project cost feasible. He briefed the Committee on his experiences.

The topics covered by the presentation included:

- A background of the specific deal with Camp Pendleton
- Analysis of the fuel cell ITC rules in place at the time
- How to monetize the ITC efficiently
- Discussion of modifications needed on the Camp Pendleton contract
- ITC's impact on the project financing
- Project organization chart developed to utilize the ITC
- A consideration of ITC impacts at other U.S. locations
- Suggestions for policies and actions beyond the ITC to accelerate market transformation and adoption of fuel cells in private and federal facilities
- Overview of the financial factors involved with fuel cell projects

Questions, Answers, and Discussion

- Dr. McCormick offered an open question to the Committee regarding the prospects of exportable power from hydrogen fuel cell vehicles for use in conjunction with smart grid technologies. He noted that defining what constitutes a power source, the pricing structure, etc., could prove to be difficult. Mr. Peterson added that under most state rules, it is currently unclear whether a facility that generates its own power is legally able to sell that power. He offered the possibility that Congress could step in to say "anybody who can make it is able to sell [it]," which would clarify the situation somewhat.
- Dr. Ross asked whether Mr. Logan considered the "premium" that a distributed, off-grid fuel cell system offers as an uninterruptible power source, noting that the cost used in his analysis (11 cents/kWh) was for standard "baseload" power. The advantage gained by utilizing fuel cells as an off-grid power source would be particularly desirable for use with data centers and other critical power applications. Mr. Logan agreed that data centers would be an excellent target market, but noted that there is still work to do to demonstrate and communicate the reliability of fuel cells to these end users.
- Dr. Ross also pointed out that MCFC systems produce high quality waste heat which can be used in CHP systems. He questioned whether the heat could be utilized in the "premium" applications like data centers, since they already have large heat rejection requirements. Mr. Logan suggested that the heat could potentially be used in absorption chillers to power the cooling system. He explained that this market is very conservative, and what is needed is one initial entity willing to act as a demonstration for others.
- Mr. van Dokkum added that 90% of the stationary fuel cell systems that UTC has installed are in a CHP configuration, since the waste heat utilization makes these systems cost effective. Therefore, the ideal sites will have both thermal and electrical demand. Mr. van Dokkum also noted that several critical data centers in the U.S. use fuel cells as their primary source of power, including the Verizon data center that controls air traffic control for the New York airports, and the data center maintained by the First National Bank of Omaha.
- Dr. Ogden asked about the possibility of receiving credits for utilizing the reformers of these distributed fuel cell systems to produce hydrogen for fuel cell vehicles. Mr. Logan expressed excitement about the opportunity, especially in providing on-site hydrogen production and storage for captive fleets (e.g., fuel cell forklift fleets at large distribution centers, etc.). He noted that systems could be designed to produce hydrogen at night and power during the day, or to utilize a control

strategy that automatically derates the cell stack in favor of hydrogen for a period of high hydrogen demand. Dr. Milliken reported that the DOE Hydrogen Program has formed a group to examine new and existing facilities in the national laboratory complex for the potential application of fuel cells. The group is exploring configurations that use CHP as well as the configuration that Dr. Ogden just mentioned, combined heat, hydrogen and power (CHHP). She introduced Mr. Pete Devlin of the DOE, who is heading up the effort to get these projects going.

- Mr. Chernoby observed that the tax credits seem very complicated to use. He agreed with Mr. Logan's suggestions for simplifying the tax policy in order to expedite the implementation of these projects.

5. ***Open Discussion***

The Committee agreed to review the draft November 2008 minutes and provide any comments to Chairman Walker. He will provide staff with a formal approval of the minutes so that they can be made public.

Chairman Walker summarized next steps for producing the HTAC's first Annual Report on the State of Hydrogen and Fuel Cell Commercialization and Technology Development. He noted that the verbiage would stay largely the same, except for addition of the new bullets suggested by the Committee and the re-ordering of sections discussed on February 18. Chairman Walker and Vice-Chairman Shaw will work with support staff to incorporate the Committee's comments into the next version. When the Annual Report document is emailed to Committee members, they should consider the report effectively final and evaluate it for major errors or omissions, so it can be issued quickly. Chairman Walker will also email the Committee the most recent draft of the cover letter to Secretary Chu for a final review. The Annual Report should be completed and submitted to the Secretary by mid-March. Chairman Walker explained that HTAC recommendations would not be included in the Annual Report because it is meant as a "state of the industry" document; the Committee would be issuing its biennial recommendations in a separate report to the Secretary later this year. He reminded members that the cover letter for the Annual Report will stress the need for the Department to follow the suggestions laid out in the National Academies study, which include most of the Committee's recommendations discussed on February 18. The letter will also explicitly recommend the restoration of the hydrogen budget in FY09.

6. ***Next HTAC Meeting***

The next meeting will be held on July 15, 2009, in Hartford, Connecticut. The Hartford/Windsor Marriot at the Hartford Airport was suggested as the meeting location.

7. ***Adjourn***

The February 18-19, 2009 HTAC meeting was adjourned at 2:12 p.m.

TENTH MEETING OF THE

HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE (HTAC)

PARTICIPANT LIST

FEBRUARY 18-19, 2009

HTAC Members Present

- Larry Bawden
- Mark Chernoby
- Anthony Eggert
- David Friedman
- Janice Hicks
- John Hofmeister
- Art Katsaros
- Alan Lloyd
- Byron McCormick
- Jim Narva
- Frank Novachek
- Joan Ogden
- Geraldine Richmond
- Bob Rose
- Philip Ross
- Ken Schultz
- Bob Shaw
- Kathy Taylor
- Jan van Dokkum
- Robert Walker

HTAC Members Not Present

- Maurice Kaya
- Michael Ramage
- Greg Vesey

U.S. Department of Energy Staff

Office of Energy Efficiency and Renewable Energy

- Jacques Beaudry-Losique
- Christy Cooper
- Peter Devlin

- Sara Dillich
- Monterey Gardiner
- Kathi Epping Martin
- Richard Farmer
- John Garbak
- Donna Ho
- Fred Joseck
- Amy Manheim
- JoAnn Milliken
- Mike Mills
- Grace Ordaz
- Carole Read
- Sunita Satyapal

Office of Fossil Energy
- Mark Ackiewicz
- Lowell Miller

Office of Nuclear Energy
- Carl Sink
- Kinghsi (Stephen) Kung

Office of Science
- John Vetrano

Energy Information Administration
- Jim Joosten
- Shawna Waugh

Office of Management
- Latanya Butler
- Rachel Samuel

Members of the Public in Attendance
- Judith Bayer – UTC Power
- Nariko Behling
- William Chernicoff – Toyota
- Philip Chizek – L3 Communications
- Michael Duffy – National Renewable Energy Laboratory
- Leo Grassilli – U.S. Navy
- Peter Hoffmann – The Hydrogen & Fuel Cell Letter

- Jamie Holladay – Pacific Northwest National Laboratory
- Donald Jones – RCF Economic and Financial Consulting
- Sam Logan – Logan Energy, Inc.
- Bill MacLeod – Hyundai
- Jenny Mandel – Greenwire
- Debbie Myers – Argonne National Laboratory
- Pandit Patil – Argonne National Laboratory
- Lee Peterson – Reznick Group
- Joel Rinebold – Connecticut Center for Advanced Technology, Inc.
- Mark Ruth – National Renewable Energy Laboratory
- Jeff Serfass –Hydrogen Education Foundation
- Neil Snyder – National Renewable Energy Laboratory
- Joseph Stanford – Sentech, Inc.
- Kevin Tynan – Argus Research
- Steven C. Weiner – Pacific Northwest National Laboratory
- Mark Williams – URS Corporation
- Bob Wimmer – Toyota
- Elvin Yuzugullu – Sentech, Inc.

Support Staff

- Judi Abraham – Conference Management Associates, Inc.
- Anna Domask – Energetics Incorporated
- Melissa Laffen – Alliance Technical Services, Inc.
- Kevin McMurphy – Sentech, Inc.
- Shawna McQueen – Energetics Incorporated
- Scott Morgan – Energetics Incorporated
- Tom Timbario – Alliance Technical Services, Inc.