

HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE

MEETING MINUTES

January 9-10, 2007

U.S. Department of Energy (DOE), Forrestal Building, Room 1E-245

JANUARY 9, 2007 – MORNING SESSION

The meeting of the Hydrogen and Fuel Cell Technical Advisory Committee (HTAC) was called to order at 9:00 a.m. EST by Dr. Alan Lloyd, HTAC Chairman. Twenty-one of the 25 HTAC members were present (list attached); members not in attendance included Dr. Uma Chowdhry, Dr. David Friedman, Mr. John Hofmeister, and Mr. Randall Napoli. Dr. Craig Venter attended the morning of January 9.

Mr. Alexander Karsner, DOE Assistant Secretary for Energy Efficiency and Renewable Energy, introduced Energy Secretary Samuel Bodman.

I. Opening Remarks from Energy Secretary Samuel Bodman

Secretary Bodman thanked the members of the HTAC for their service and expressed his appreciation for their time and effort. He offered special thanks to Dr. Lloyd (HTAC Chairman) and the Honorable Robert Walker (HTAC Vice Chairman) for their leadership roles. The Secretary reiterated his regrets for not being able to attend the first HTAC meeting in October 2006 and said he was happy to be able to be here for the second face-to-face meeting.

Secretary Bodman described his goal to seek the expertise of the distinguished members of HTAC and get their critical and independent judgment about what DOE is doing to advance the country's national security, focusing in particular on the Hydrogen Fuel Initiative. He noted President Bush's ongoing commitment to hydrogen and fuel cells, and observed that the focus on hydrogen and fuel cells generates a lot of bipartisan support in Congress. The Secretary expressed his confidence that hydrogen and fuel cells will be one of the keys to a clean and secure energy future for the nation. He further noted that they are central to the President's Advanced Energy Initiative and to his long-term energy strategy.

The Secretary reported that DOE agrees with the Committee's recommendation to create an Interagency Task Force at the Assistant Secretary level, and that it should address policy issues. He informed the HTAC that DOE is currently working to create this Interagency Task Force, as the Committee recommended.

Secretary Bodman proceeded to report on DOE spending and budget requests for hydrogen and fuel cells:

- Since the President announced the Hydrogen Fuel Initiative in 2003, we have increased spending by \$500 million over previously planned levels.
- We have made good research and development (R&D) progress.
- The DOE fiscal year (FY) 2007 budget request for hydrogen programs was \$288 million; we do not know yet how the final 2007 budget will look when a Continuing Resolution is passed by Congress, and what restrictions, if any, it will place on funding earmarks.
- The Continuing Resolution may hold us to the FY 2006 budget of \$232 million; even at this level (and particularly if there is a significant restriction on the number of earmarks that are applied)

we are confident that we will be able to move ahead with the programs that are currently underway.

The Secretary noted that while R&D progress has been made, there are still substantial technical challenges going forward. He urged the Committee members to let DOE know what they think about the research strategy: Are we missing anything? What more can be done? What should our priorities be? He also asked for HTAC's input on broader questions as we move closer to putting fuel cell vehicles on the road and as fuel cell systems come to the market in niche applications such as forklifts, back-up power and portable electronic devices in the market. He suggested questions such as: How can we encourage building the hydrogen infrastructure that we need when the present level of demand is still low? How can we accelerate safety, codes and standards? How can we work better to accelerate market penetration of hydrogen technologies?

The Secretary declared that, particularly under Assistant Secretary Karsner's leadership, he is very enthusiastic about the prospects for this body of technology and for the possibilities that it offers. He reaffirmed that the DOE earnestly seeks the collective input of the HTAC and its help in making judgments on program priorities in the face of potentially restrictive budgets.

Secretary Bodman then asked for questions and comments.

Question: Mr. Walker asked the Secretary to describe his opinion on the connection between hydrogen and nuclear energy.

Answer: Secretary Bodman replied that he sees nuclear energy as one area within DOE that ties in closely with the Hydrogen Initiative. DOE has a variety of programs in this area, including the recently formed Global Nuclear Energy Partnership (GNEP), an international effort aimed at developing advanced technology that could allow for worldwide expansion of nuclear power without providing a target for nuclear "proliferators." The Secretary asserted that nuclear powered electrolysis will help produce hydrogen in a fashion that enables us to generate hydrogen in large quantities for use in vehicles and stationary fuel cells.

Question: Dr. Michael Ramage observed that there seems to be significant bipartisan support in Congress for expanding renewable programs. He asked whether the Secretary is starting to feel pressure about the Coal Program. He noted that FutureGen could contribute to our ability to use domestic resources to produce hydrogen, but there are those who have concerns about coal in light of the growing worries about climate change.

Answer: The Secretary replied that he is not yet feeling a lot of pressure on this and has not yet given any testimony on this subject. He has received significant interest in DOE's FutureGen program from the Chinese and Japanese, and there is significant international interest and involvement in that program.

Question: Mr. Michael Mudd noted that the Secretary mentioned budget restrictions. Are there opportunities to increase the overall budget for DOE or is this really a zero-sum game?

Answer: The Secretary replied that DOE continues to make the case to Congress that the focus of DOE needs to be increasingly on science. The focus on science is important, and the budget the President sent to Congress called for a \$500 million increase in funding for the Office of Science, which funds a large percentage of the nation's fundamental physical science research. The Secretary stressed that he could not say that it won't be a zero-sum game, because there is a focus on keeping the overall budget flat or down. He went on to say that the Department does, however, have a very large annual budget—close to \$23 billion/year. He pledged to continue his efforts to better manage the existing programs and spending so that we can make progress in our scientific initiatives while keeping budgets flat.

Question: Dr. Robert Shaw noted that over the past 25 years we have seen the manufacturing of solar technology move off shore—the technology was created in the U.S., but we are not the leaders in manufacturing or commercialization. Dr. Shaw worries that the same thing may happen in the hydrogen area. Can DOE take a more aggressive role in helping to ensure we get some economic benefit from the hydrogen technologies that we create and develop in the U.S. by stimulating a U.S. manufacturing sector for this technology?

Answer: Secretary Bodman offered his observation that there still appears to be a strong solar business in this country, and that he is very impressed by what he sees happening in the private sector today. He is optimistic because for the first time in 50 years he is seeing significant investments in alternative fuels by professional venture capitalists. He acknowledged that much of the manufacturing in the solar industry has moved to Japan and Germany, due in large part to the government subsidies that are provided in these countries. The Secretary replied that the DOE is doing its best to encourage industry investment in commercialization and manufacturing. He noted that DOE is working to improve technology transfer from the national laboratories so that all the labs are more effective at doing this. He asked the HTAC for input on specific steps that DOE could take and asserted that DOE would be very interested in and receptive to these inputs.

Question: Dr. Lloyd asked the Secretary whether he sees climate change and the pressure for reductions in greenhouse gases as a key driver for new technologies, and whether/what role the International Partnership for a Hydrogen Economy (IPHE) has in this area.

Answer: The Secretary replied that Senator Bingaman, Chairman of the Senate Committee on Energy and Natural Resources, is a believer in issues related to global warming and in promoting technologies to address this. He further noted that we currently spend \$2 billion on global climate science and \$3 billion on global climate technology, and that the increasing interest from Congress in this should help to build support for our science and research programs.

Secretary Bodman wrapped up his comments session by reiterating his appreciation to the HTAC members for their service. He closed by saying that that he looks forward to receiving their comments and stated that he would do his best to be responsive to their inputs. The Secretary then left the meeting.

II. Remarks from DOE Assistant Secretary for Energy Efficiency and Renewable Energy (EERE) Alexander Karsner

Assistant Secretary Alexander “Andy” Karsner opened by recalling that one of his first official acts at DOE was to sign the HTAC into being. He remembered the diligence of Mr. Steve Chalk, former Program Manager of the Hydrogen, Fuel Cells & Infrastructure Technologies (HFCIT) Program, in getting his early attention on this, and remarked that Mr. Chalk continues to be one of EERE’s stellar program managers. Assistant Secretary Karsner stated that he was very impressed by the qualifications and expertise of the 25 HTAC members and is looking forward to their input and recommendations on the Hydrogen Posture Plan and the Hydrogen program.

He advised that as a newly formed technical advisory committee, the HTAC has the advantage of new ideas, growing momentum, and freshness, and he hopes that the Committee will see this as an opportunity. He described his belief that the HTAC is a part of the continuum of DOE’s pipeline from research to development to demonstration. As the end of the pipe that faces outward towards the market, he suggested that the Committee has the responsibility to help DOE figure out where the nexus might be between market pull and technology push, and how DOE can play a role.

Assistant Secretary Karsner emphasized that the DOE portfolio is more than technology. It is a “3-legged stool” composed of R&D, Policy, and Capital Markets. He noted that the Department has not focused much on the latter two areas, and that the HTAC is in a position to make recommendations that will help DOE improve in these areas and use available tools so that R&D can manifest itself sooner in the marketplace. He stressed that the theme for how he views the challenges we face is the word “sooner.” With about 24 months before the next Administration, Mr. Karsner seeks to lay a solid foundation for continuing progress from what has been a very transformational period for all these technologies, especially hydrogen. In this regard, Mr. Karsner pledged to move forward quickly on the Committee’s recommendations (e.g., formation of the Assistant Secretary-level Interagency Task Force, which he approved) and noted that the Secretary has made the theme of urgency a top-line item in EERE’s strategic mission. He stated that the HTAC members, collectively or individually, are welcome to meet with him at any time to discuss ideas.

The Assistant Secretary encouraged the HTAC to go further than just the Posture Plan. He further encouraged the Committee to look at the entire portfolio and all the tools that are available for hydrogen and fuel cells (e.g., the Federal Energy Management Program (FEMP), EnergyStar, state energy programs, the implementation provisions of EPACT, etc.). In closing, Mr. Karsner thanked the Committee members again and assured members that their recommendations would be taken seriously and acted on speedily.

Assistant Secretary Karsner then asked for questions and comments.

Question: Dr. Lloyd praised Mr. Karsner’s conviction that timing is very important and supports the view that facilitation of commercialization is very important. Does the HFCIT program have the internal staff resources that are necessary to meet the schedule and the DOE’s important goals?

Answer: Mr. Karsner replied that there is an active advertisement for the position of HFCIT Program Manager. He expressed his confidence in the current management team, in Dr. Milliken as the acting Program Manager, and in the Program’s staff. In speaking with the hydrogen management team about the importance of credibility and clarity, he learned from them that a critical need for the program is defining with greater poignancy the critical path forward and what is necessary to maintain it. Mr. Karsner stressed that DOE will do what is necessary to meet the President’s commitment; if the Committee sees a deficiency, then he urges them to be open and candid about it so that DOE can find ways to address it.

Question: Mr. Jan van Dokkum noted that the Secretary talked passionately about science and what science can offer towards getting hydrogen and fuel cells to the marketplace. He further noted that Mr. Karsner spoke about the need for engagement of the capital markets and market creation. Mr. van Dokkum asked if DOE has plans or ideas on how we can get the science that is being developed at a rapid pace into the market. He stated that there does not seem to be a lot of encouragement to adopt these new technologies and asked if there are ideas on how this can be improved.

Answer: In response, Mr. Karsner recalled his professional background as a businessman in the energy field and the particular skill set that he offered when he accepted the job as Assistant Secretary, as someone who could help to bring these technologies to market. He asserted that a top-line goal for his team is to introduce more agility and responsiveness into government programs that can help with improving market adoption of these technologies. He underlined the need for partnerships with the private sector in making this happen and stressed that the federal government cannot drive this exclusively. He sees the need for more detailed action plans that help describe how these programs should operate; for example: How can we get more fuel cells into buildings through the FEMP program? Under what conditions should they be procured for buildings and in what applications or locations should they be considered a priority for procurement? He offered the loan guarantee program, authorized in Title XVII of EPAct, as another key opportunity. He noted that Title XVII provides wide latitude for how to

use the government balance sheet for virtuous technologies, including hydrogen and fuels cells, and encouraged the HTAC to think creatively about new and innovative ways that funded loan guarantees could be applied. Mr. Karsner also requested the Committee's feedback on the value of EnergyStar labels for hydrogen and fuel cell technologies, and whether this is something that the Department should pursue. He closed by saying that these are some of the ideas that DOE is considering, but he would be happy to receive other suggestions from the Committee.

Question: Professor. Geraldine Richmond described the decline in DOE funding over the past two decades for fundamental scientific research on renewable energy and noted that many scientists have been forced out of the field due to a lack of funding. She noted that the research community was very excited about the prospects for increased funding of basic science on renewables in the 2007 budget, but it appears that the Continuing Resolution may put this on hold. Dr. Richmond inferred from the Secretary's remarks that there may be a possibility that, even under a Continuing Resolution, funds could be shifted around within the Department to fund some of these new starts in FY 2007. She asked Assistant Secretary Karsner if this was a reasonable possibility or not.

Answer: Mr. Karsner replied that the rules and processes for how this Continuing Resolution will be resolved are not his area of expertise. He offered the current expectation, which is that the EERE budget in the Continuing Resolution will come to DOE as a top-line budget number, based on what was provided in 2006 (without the "walls and silos" prescribed in a normal budget), and that it will exclude new starts. He noted, however, that he does not think there are, fundamentally, any truly new starts in a program that is a 25-year evolutionary program. If the budget is provided in this fashion, then it would, he claimed, offer an unusual degree of latitude in how the funding is spent compared to previous years.

This concluded Assistant Secretary Karsner's remarks.

III. *Vision of the end state and transitions to a hydrogen economy (Vision, Scenarios, Early Transitions, End Game and Back Casting): David Friedman*

This presentation was deferred to the HTAC meeting in May 2007. Dr. Friedman was unable to attend the HTAC meeting due to illness and the co-presenters (Dr. Roger Saillant and Dr. Robert Shaw) declined to present in his absence.

PROCESS NOTE: While the minutes are presented in order of the published HTAC agenda, the sessions that immediately followed Assistant Secretary Karsner's remarks during the HTAC meeting were items VII and VIII: presentations by Dr. Byron McCormick and Mr. Larry Bawden.

IV. *Swearing in of HTAC Members: DOE Human Resources*

The swearing in of HTAC members was deferred to the next HTAC meeting in May 2007. The swearing-in process could not proceed as planned due to the need for additional paperwork from the HTAC members. The required forms were distributed to the members, to be completed and returned to DOE.

V. *Ethics Review: DOE General Counsel*

The ethics review was conducted on the evening of January 9, 2007. This session was not included as part of the public HTAC meeting, since it involved the disclosure of Committee members' personal information.

VI. Review Agenda, Review and Approve 11-17-06 Minutes, Review HTAC Deliverables and Milestones

Agenda: The following agenda items were postponed until the May 2007 HTAC meeting: 1) presentation by Dr. David Friedman on the HTAC vision; and 2) swearing in of HTAC members.

11-17-06 Minutes: Chairman Lloyd moved to approve the minutes from the November 17, 2006, HTAC meeting held via conference call. The motion was seconded and passed unanimously by the Committee without further discussion.

HTAC Deliverables and Milestones: Ms. Kathi Epping (DFO) reported the following deliverables relative to the Hydrogen Technical Advisory Committee:

- *October 2007:* HTAC submits first Biennial Report on DOE Hydrogen Posture Plan (Sec. 804 Plan)
- *February 2008:* Secretary of Energy submits first report to Congress, including Secretary's responses to HTAC recommendations
- *October 2009:* HTAC submits second Biennial Report on Hydrogen Program
- *February 2010:* Secretary of Energy submits second report to Congress, including Secretary's responses to HTAC recommendations
- *October 2011:* HTAC submits third Biennial Report on Hydrogen Program
- *February 2012:* Secretary of Energy submits third report to Congress, including Secretary's responses to HTAC recommendations

VII. Transportation White Paper prepared by ad hoc group of multiple companies

Dr. Byron McCormick delivered a presentation developed by an *ad hoc* group of companies who meet periodically to discuss issues related to the hydrogen transition. He explained the purpose of the group as offering a means for frank and open discussions among participating auto companies, energy companies, industrial gas companies, and equipment suppliers. The group (which he described as global in nature) was formed expressly to permit discussions without attribution, and so the member's names and organizations are not revealed unless the members themselves choose to do so. Dr. McCormick stressed that lawyers are present at the meetings of the *ad hoc* group and that no corporate policies are discussed at the meetings. He introduced several subject matter experts present at the HTAC meeting: 1) Ms. Julie Beamer, General Motors (GM) Director of Fuel Cell and Hydrogen Commercialization; 2) Ms. Britta Gross, also of GM, who deals with an array of vehicle-infrastructure interface issues; 3) Dr. Chris Sloan, GM, who works on codes and standards issues; and 4) Mr. Jesse Schneider, DaimlerChrysler, who is very familiar with ongoing codes and standards efforts.

To frame the discussion, Dr. McCormick noted that the automotive companies represented within HTAC embody more than \$1 billion in R&D, which is directed towards an end, ensuring that the U.S. automotive industry is sustainable and strong, going forward, and is responsive to societal needs. He cautioned that there may be a disconnect between the timeline proposed in the Hydrogen Posture Plan and the timing for when the automotive companies expect to bring large numbers of vehicles to market. In this regard, the lead time required to build the supporting vehicle infrastructure is critical.

In his first slide, Dr. McCormick presented the *ad hoc* group's perspective on a plausible pathway to commercialization. The pathway spans 2006 - 2015 and consists of three timeframes: now through 2009; 2010 to 2012; and 2013 and beyond. He described the three pathways as follows:

2006 - 2009: “Technology Development” Phase

- Production of 100 hydrogen-powered fuel cell vehicles (FCVs) per automotive company (or “original equipment manufacturer” [OEM])
- Vehicle cost of \$1 million each (for production only – does not including engineering and support costs)
- Focused largely on vehicle demonstrations and validations in California (Los Angeles), due to existing state policies (zero-emission vehicle mandates) and the likely construction of 5-10 fueling stations in L.A. during this timeframe
- Growing consensus on standards for filling stations, including the need for 700-bar refueling and high-pressure storage

2010 - 2012: “Pilot Commercialization” Phase

- Production of 500 - 1,000 vehicles per OEM (Dr. McCormick stressed that these are not *commitments* by the automotive companies, but that these are reasonable targets depending on government policies. He reported that in GM’s case, this scale of development is already ongoing.)
- Vehicle production cost of \$250,000 each
- Continuing focus on Los Angeles, CA
- 25-75 fueling stations in the L.A. metropolitan area, and 10-25 stations along the highways

2013 and beyond: “Early Commercialization” Phase

- Production of up to 10,000 vehicles per OEM
- Vehicle production cost ramping down as larger-volume manufacturing processes come on-line (\$50,000/vehicle in 2013, \$10,000/vehicle by 2015, and moving downward from there)
- 200 metropolitan-area fueling stations and 50 stations along the highways

Dr. McCormick drew attention to the bottom half of the “Pathway to Commercialization” slide: the issue of *lead times* and the need for *incentives* to assist in bridging the “valley of death,” when vehicle costs are very high. He emphasized that lead times are key -- that because it takes a long time to site, permit and construct a hydrogen fueling station, the lead time for the 2010-2012 stations is *now*. In discussing the need for incentives, he pointed out that the level of investment on the part of the automotive companies will be huge: \$6 to \$10 billion per OEM over the 2006-2015 timeframe. He explained that each step along the pathway from low- to high-volume production involves the building of a supplier base and manufacturing infrastructure to support it. He noted that the process of moving from hand-built to soft-tooling to replicate-able designs to full capitalization is a very capital-intensive effort, and that many supplier organizations will not have the capital resources to make this move, especially given uncertainties in the demand and timeframe for the products.

Assistant Secretary Karsner questioned the cost of new manufacturing facilities and whether this \$6-10 billion investment includes this cost. The OEMs pointed out that the plan is to retool existing assembly plants rather than to build completely new facilities. However, the cost of retooling is likely in the range of \$1 billion per vehicle model, since they will be renewing most of the vehicle in order to optimize its integration with fuel cell hardware. With respect to supplier organizations, Dr. McCormick offered the example of membrane materials needed for fuel cells in vehicles. He reported the outcome of his discussions with several membrane suppliers—to provide membranes at the cost that is ultimately desired by the automotive companies, the market would have to be 1 million cars per year, and the membrane production facility (and capital required to build it) would need to be large-scale. At lower production volumes, the cost of membranes will be high, and will contribute to the high initial costs of fuel cell vehicles.

Asked by Dr. Ramage whether the costs are dependent on scientific and technical advances as well as higher volume production, Dr. McCormick replied that the numbers presented in the *ad hoc* group's slides are based on what the OEMs know they can do in this timeframe with technologies that are in development, design or production. He asserted that the science is a lot closer than is widely understood, but that the necessity to protect intellectual property prevents individual companies from divulging the specifics. Asked about assumed precious metal loadings in the fuel cells, Dr. McCormick responded that the *ad hoc* analysis assumed a platinum loading of 0.15 mg/cm².

Professor Mildred Dresselhaus asked how the infrastructure investments made over this timeframe could take advantage of new science and technology that emerges in the future. While not addressing this question directly, Dr. McCormick stated that while scientific advances could clearly offer improvements, the business case is viable with existing technologies, and that support from the highest levels within the auto companies bears this out.

Dr. Lloyd raised the potential for a breakthrough in battery technology that enables lower costs, longer lifetimes, and shorter recharging times. He asked if GM would drop its plans for hydrogen FCVs if such a breakthrough were to occur. Dr. McCormick replied that this possibility has been considered, and that GM considers the two technologies to be synergistic rather than competing. A breakthrough in battery technology would be advantageous for fuel cell vehicles, since the car of the future is envisioned as a hybrid battery/fuel cell vehicle.

Several questions arose relating to the consumer market—at what point is the customer prepared to buy the vehicle? When will consumers start driving these vehicles? Why will the customer want to buy a fuel cell vehicle in particular? Dr. McCormick stated that from GM's perspective the 100 GM vehicles now operating in California are defined as a test market, and they are gathering data to understand their usage by both businesses and daily consumers. He noted, however, that niche markets will not meet anyone's goal (industry, government or society), and that widespread deployment is necessary to have an impact on societal goals. Therefore, he asserted that the "valley of death" must address the pilot commercialization phase and the issue of business sustainability during this timeframe. He emphasized that government policies, U.S. and globally, will be key. Mr. Chernoby pointed out that policies could affect the "total cost of ownership" for the consumer, which can provide subjective benefits that are difficult to capture monetarily (such as the ability to drive in special lanes on the highway, preferential parking, insurance costs, low emissions profiles, etc.). Dr. McCormick described other aspects of the consumer value proposition for fuel cell vehicles: the electric drive provides torque when the driver wants it, a smooth and quiet ride, and motor responsiveness measured in tenths of a millisecond. The split motor design will also enable the vehicle to control the force on all four wheels, which will improve drivability and safety.

Dr. McCormick was questioned whether there are any plans for putting reformers onboard vehicles as a contingency plan, in case the refueling infrastructure is out of phase with the introduction of vehicles. He replied that this was definitely not being considered, for the following reasons. First, doing so makes the cost of the vehicle too high. Second, this creates emissions from the tailpipe. And lastly, hydrogen storage at refueling stations enables renewables to play a role in hydrogen production.

At this point, Assistant Secretary Karsner excused himself from the meeting with his regrets, and stated that he would have members of his staff on the Commercialization and Deployment team sit in on the remainder of the meeting. He encouraged the HTAC members to visit his office at any time to share ideas, and reaffirmed his desire to act quickly on their recommendations.

Dr. Shaw observed that the commercialization pathway chart presented by Dr. McCormick and the *ad hoc* group looks like a fairly standard business plan for development of any technology. He speculated on whether it would be possible for GM to spin this off as a separate business unit rather than trying to carry

it on the company's balance sheet, and asked Dr. McCormick if he thought that investors would find this attractive. Dr. McCormick, replying from his personal perspective rather than as a GM employee, stated that investors would likely not have the patience for the "valley of death" shown in the chart. He noted that bridging the "valley of death" will require a complex set of partnerships with government, suppliers, and the fueling infrastructure. Dr. Shaw asked why GM would pursue this as a business plan if private capital would not buy it. Dr. McCormick noted (again from his personal viewpoint) that while the business plan is risky, it also is a matter of industry survival and doing the right thing socially. He and others noted that there is also an issue of scale: this technology development pathway involves a reinvention of the transportation and refueling infrastructure and represents massive change in a relatively short period of time. Dr. Shaw questioned providing subsidies to larger companies when small companies are not asking for them. Dr. McCormick and others noted that this is an issue that the HTAC will need to consider as it formulates recommendations for its report. It was noted that the OEMs are keeping a lot of small manufacturers in business, since many of the parts required for automobiles are not directly manufactured by the OEMs.

Continuing with the *ad hoc* group's presentation, Dr. McCormick discussed three "Fundamental Enablers to Successful FCV Commercialization," which are cross-cutting to all the barriers. First is the underlying need for consistent national leadership on a national energy strategy and the role of hydrogen and renewables. He emphasized that a "solution-of-the-year" approach will not work. Second, the group pointed to the need for sustained, long-term, compelling incentives for automakers, suppliers, infrastructure providers, and customers (including large and small companies). He noted that government-as-customer can play an important role in early demand development, similar to what has happened in Japan with stationary power. Thirdly, the *ad hoc* group maintains that a geographic focus is essential to ensure successful, coordinated vehicle/infrastructure market introduction. Because it is not affordable to provide early vehicles and infrastructure across the entire U.S. (or even across an entire state), there is a practical need to start in a particular location and grow it out from there. This will enable the required concentration of both vehicles and infrastructure to get to stations that see 100 vehicles per day in the early years. The group concedes that maintaining a small geographic focus could be very challenging politically, but agrees that it is essential for success.

Dr. Milliken introduced two members of Assistant Secretary Karsner's staff who are part of his Commercialization and Deployment team: Mr. Brad Barton, who leads the team, and Mr. Michael Bruce.

Dr. McCormick introduced Ms. Julie Beamer, GM's subject matter expert on fuel cell and hydrogen commercialization, to present the *ad hoc* group's summary of near-term barriers to market introduction of fuel cell vehicles that the HTAC can help to address. With regard to "station siting, permitting and liability exposure," she identified the patchwork of regulatory, legal, and social issues as a key barrier affecting a lot of different areas, including refueling and servicing vehicles. Experience has been that regulatory processes and requirements differ state to state and location to location. There is a need to standardize some regulations and provide incentives to localities to adopt the standards and permitting templates. Ms. Beamer identified concerns over unlimited liability as another key near-term barrier. She noted the lack of extensive experience, especially with 700-bar refueling, that is needed for insurers to adequately assess the risks. She identified the need to develop mechanisms for limiting liability associated with early fueling station deployment (e.g., government pools and affordable insurance). Addressing liability concerns is essential to providing open access to stations, which is needed. The long lead times required for siting and building fueling stations on private property was cited as another barrier. One way to speed the process is to provide for the use of public property for early fueling stations (e.g., the Air Quality Management District refueling site in Burbank, CA). Creative solutions for addressing "not in my backyard" (NIMBY) are also needed, including ways to provide incentives communities (e.g., through services).

Ms. Beamer identified storage and compression requirements as key considerations in the category of “station equipment and footprint.” She described the automakers’ conviction that 700-bar (high-pressure compressed gas) refueling is essential: advantages include fast-fill capability and smaller footprint for storage on the refueling site and on-board the vehicle. In the category of “hydrogen quality and purification,” the group recognized the need to balance requirements for fuel cell-quality hydrogen with the cost of the fuel. Ms. Beamer communicated the group’s support for continued funding of R&D at the University of Hawaii and elsewhere to understand the impacts of hydrogen purity within a three-year period, so we can move forward with hydrogen quality standards and measurement technologies at retail sites. The key barrier in the category of “supply base development” was identified as early capitalization risk, and the fact that the majority of the supplier companies do not have the capital to invest in developing technologies with uncertain demand and timelines. Incentives are needed to induce these companies to invest. Finally, in the category of “codes and standards,” Ms. Beamer described the need for *interim* standards that enable fuel cell vehicles and infrastructure to operate in the near term. She stressed that the interim standards should maintain flexibility to allow for rapid revision as knowledge and experience are gained.

Ms. Beamer described a particular example with the regulatory process in New York City. She explained that despite a huge level of effort, it was very difficult to determine which agencies (Metropolitan Transit Authority, New York City Department of Transportation, New York and New Jersey Port Authorities, etc.) had jurisdiction over the different bridges and tunnels, what the access for hydrogen vehicles is, and what level of enforcement is applied. The port authorities there will not allow trucks carrying compressed hydrogen to cross the bridges over which they have jurisdiction, because they do not have a special exclusion. Ms. Beamer said that it is unsustainable to put this level of effort into deciphering the regulatory requirements location by location. Dr. Shaw pointed to another example in Westchester County, New York, where a permit for an on-site hydrogen reformer was denied because it was viewed as a chemical manufacturing operation.

Dr. Lloyd asked how the HTAC could contribute in these areas, and Ms. Beamer replied that the *ad hoc* group thinks that HTAC can contribute in *all* of these areas, particularly on the items identified as “needs.” She stated that HTAC’s Subcommittee on Near-Term Implementation Barriers ought not focus on identifying the barriers; rather, the HTAC should consider the list of barriers and needs that industry has identified and develop an action plan or roadmap for how to address these needs, including: 1) Who (public/private players), (2) What resources, (3) What funding, (4) How (mechanisms), and (5) Timeline. Dr. McCormick offered the subject matter experts as resources for the HTAC in exploring the barriers and needs in more detail.

Mr. Walker asked whether the group considered fueling options other than traditional refueling stations, such as home-based reformers. The reply was that they had not, because there is a need to move forward now on something specific—to choose a path forward and conduct the analysis and work necessary to make it happen, and then move forward from there. Dr. Saillant speculated on whether there should be a single point person centered in one office, who would be in charge of coordinating federal activities on hydrogen and fuel cells (a “guru” of hydrogen).

VIII. *Portable Power and Stationary Applications White Paper prepared by committee members*

Mr. Lawrence Bawden (President and CEO, Jadoo Power Systems) opened by saying that portable power shares many of the same barriers described in the previous presentation on transportation. One key difference is that a car carries 6,000 grams of hydrogen for a 300-mile distance, whereas a portable device only carries about 9 grams of hydrogen. Mr. Bawden described the portable market as here and now: Jadoo is one of 50 companies bringing portable fuel cell products to the market, and offers more than

1,000 products sold throughout the U.S. He stated that if the barriers that exist today are eliminated, the market could expand to include more than 10,000 products. Research on advanced fuels is underway in all the portable power companies—research that could accelerate hydrogen storage technologies in other applications. For example, Jadoo has openly discussed its efforts to develop improved metal hydride, sodium borohydride, and advanced ammonium borane storage technology (which has a capacity of up to 1,500 kWh/kg hydrogen). The Jadoo product used as an example in this presentation was a fuel cell powered professional broadcast camera. Mr. Bawden explained that the product offers advantages over its battery-powered counterpart: it is lower cost, has a longer runtime and a shorter recharging time, and is guaranteed for the same life as a battery system. The top barriers to widespread deployment are two: 1) patchwork regulations, and 2) the inability to transport the product using common carriers (and associated liability) due to lack of accepted codes and regulations.

Mr. Bawden cited variations among the more than 25,000 individuals throughout the U.S. who make decisions on fire codes and permitting, which has resulted in a very wide range of costs (\$0 to \$13,000 per tank) for installing small (1,000 gram) compressed hydrogen tanks at user facilities. He explained the biggest barrier to portable fuel cell devices in general is the inability to ship the fuel canisters in the U.S. via ground or air cargo transport, or to carry the devices on passenger planes. This is because codes and regulations have not yet been developed and accepted by the authorities having jurisdiction. Testing shows that the canisters are as safe as or safer than many products commonly carried in cargo planes or passenger aircraft (e.g., propane canisters or lithium-ion batteries). However, the special permits currently granted for the metal hydride canisters used in these products classifies the hydrogen as a hazardous material with cumbersome handling requirements, penalties for non-compliance, and exposure to higher liability. Mr. Bawden explained that this creates a competitive disadvantage versus battery-operated devices. He asserts that what is needed is an expedited process for conducting intensive, independent testing of the devices followed by the swift adoption of appropriate codes and standards for transport on all carriers.

A discussion ensued about how the public perceives risk, and the difference between actual and imagined risk. Dr. Dresselhaus expressed her hope that, in addressing the issue of risk, the HTAC would make a statement about the differences between the properties of hydrogen (a lightweight flammable gas) and heavyweight flammable substances (e.g., gasoline). Mr. Arthur Katsaros recommended that the Committee base its recommendations on technical data and an understanding of the DOE (and DOT) programs on safety, codes and standards. He suggested that the HTAC review these programs in the course of their work. The Committee later agreed that it would include a briefing on Safety, Codes and Standards activities at the May 2007 HHTAC meeting.

Dr. Sloan, a GM subject matter expert on codes and standards, offered the opinion that there is a difference between what is perceived in the absence of knowledge versus fact. She suggested that the most effective way to address this is through educational packages directed towards consumers (such as those developed by Next Energy and the California Fuel Cell Partnership). These packages should appeal to common sense and describe things like the properties of hydrogen, the risks of hydrogen versus other commonly used materials, the safety devices employed, the experiences to date, etc. She suggested that education and training be provided to the “authorities having jurisdiction” (AHJs) in ways that are designed to assist them in doing their jobs. She recommended permitting templates and funding for training sessions as two effective mechanisms for working with AHJs. She proposed that the Federal government can help, since they are viewed as a third party without a vested interest, and would recommend that the HTAC endorse DOE’s support for educational activities.

Dr. Milliken described the education products developed over the last 1-2 years in HFCIT’s Education subprogram (led by Ms. Christy Cooper):

- Former Energy Secretary, Spencer Abraham took “Hydrogen 101” seminars around the country, focusing on areas where hydrogen fuel cell vehicles are being demonstrated.
- An on-line training tool for first-responders has recently been released.
- Fact sheets for the public are posted to the HFCIT website.
- Radio spots targeted towards children are being aired.

Dr. Roger Saillant commented that the budget for HFCIT’s educational effort is very small compared to the task. He also returned to the idea of a coordinated Federal effort on hydrogen and underlined the need to involve the Department of Education in getting educational materials to the K-12 population. He asserted that this is necessary in order to change entrenched values and habits in future generations. Dr. Dresselhaus reminded the Committee that professional societies are also an important contributor to education, especially with regard to providing science-based, factual information.

JANUARY 9, 2007 – AFTERNOON SESSION

IX. DOE Infrastructure Activities

Dr. Milliken introduced Dr. Sigmund Gronich, Technology Validation and Scenario Analysis Manager, and Mr. Fred Joseck, Technology Analyst, both from EERE’s Hydrogen, Fuel Cells and Infrastructure Technologies Program. She mentioned the program’s recent efforts to develop infrastructure and scenario analyses, in partnership with industry. Mr. Chernoby pointed out that the timelines described in the previous presentation from the *ad hoc* group (up to 10,000 vehicles per OEM in 2013) assumed some policy incentives and optimism that we can overcome the game-changing barriers. He pointed out that the DOE scenario analyses considered more conservative market penetration rates. Dr. Milliken reminded the Committee that the DOE analysis is bounded by the President’s timeline for the Hydrogen Fuel Initiative, as stated in the 2003 State of the Union address.

Dr. Gronich began by reviewing the motivation for the scenario analyses, namely: 1) recommendations in the 2004 report by the National Academy of Sciences (NAS) for transition analysis and policy analysis; and 2) EPA Act Section 811, which requires the Energy Secretary to submit a report to Congress on “measures to support the transition to a hydrogen economy, including those related to producing and deploying hydrogen fueled vehicles and infrastructure.” He noted that the NAS report included a market penetration scenario that put 10 to 12 million vehicles in the marketplace over about a 10- to 12-year period.

Dr. Gronich explained that the DOE scenario analyses are attempting to respond to these requests by looking at different market penetration scenarios for vehicles and infrastructure, as well as the impact of public policies and how government can play a role. He noted that two of three workshops designed to gather industry input on the analyses have already been conducted, and the third is scheduled for January 31, 2007, in Washington, DC. He added that the meetings have been well-attended with a wide range of industry representatives, including fuel cell developers, energy companies, U.S. and foreign auto companies, industrial gas companies, state governments, universities, and so on. He noted that early on in the process, the auto industry emphasized the need for the application of realistic learning curves in the analyses. He reported that, working with USCAR, a composite learning curve has been developed that is agreed upon by all three U.S. automakers. Learning curves are also being developed for the infrastructure side of the analysis.

Dr. Gronich stated that the intention is to produce a scenario analysis report for the NAS Committee (chaired by Dr. Ramage) in the March-April (2007) timeframe. He also added that he will provide a more

detailed presentation of results of the scenario analyses at the NAS Committee's first meeting, scheduled for February 20-22, 2007.

Dr. Gronich briefly described the learning demonstration project that is testing vehicles and infrastructure in the real-world, gathering data on performance, and feeding this information back into the R&D program. He reported that the Phase 1 tests of Generation 1 vehicles (using 2001- or 2002- technology) demonstrated an average of 700-hours durability (950 hours, or 30,000 miles, maximum). The Generation 2 vehicles (2006 technology) will include high-pressure storage tanks as well as improved fuel cells. He indicated that these vehicles are expected to demonstrate 1,500 to 2,500 hours durability by the end of the testing period in 2009. The ultimate target for fuel cell durability is 5,000 hours (equivalent to 150,000 miles). He reiterated that the current Technology Validation Program is designed to feed into the overall Program's goal of demonstrating in the laboratory that the ultimate targets could be met by 2015, so that industry could then opt to commercialize and put production vehicles in showrooms around 2020.

The scenario analyses take this a step farther by considering the impacts of different policies and by proposing to extend the learning demonstrations by building out infrastructure to support more vehicles as part of a "Lighthouse Validation" network. He said that one of the strongest messages from the meetings with industry was to focus vehicles and infrastructure in select urban clusters—as opposed to along corridors (highways) or scattered among many different locations. He also emphasized that the automotive industry was clear in its support for a more aggressive scenario than putting vehicles in the showroom in 2020.

Dr. Gronich continued with his discussion of the scenarios, with the caveat that DOE is not recommending any one particular scenario. Rather, the scenarios are being developed as a plausible range to assess infrastructure needs and for decision-makers to consider. He described the scenarios and the selection of Los Angeles and New York City as the two initial urban clusters, with a plan to spread out in a cookie-cutter approach that would lead to 20 or so cities over a 10-year period. Dr. Gronich noted that the most aggressive scenario is Scenario 3, which most closely tracks the market penetration scenario proposed in the 2004 NAS report, with thousands of fuel cell vehicles by 2012, such that market penetration is 10 million by 2025. Scenarios 1 and 2 are less aggressive, getting (respectively) to 2 million vehicles and 5 million vehicles by 2025. Dr. Ramage interjected here to say that the NAS referred to its scenario as "optimally plausible" based on an analysis of the penetration rates of front-wheel drive and hybrid-electric vehicles and no fuel availability issues.

Dr. Gronich presented a chart comparing the market penetration rates of the three scenarios with what has been experienced for hybrid electric vehicles (HEVs), and noted that Scenarios 1 and 2 track the HEVs relatively closely. Scenario 3 has much higher penetration rates, with two to three times more vehicles entering the market beyond 2018. In response to a question about whether the analyses assumed that a range of vehicle models would be available, Dr. Gronich replied that the modeling does take this into account, and that this is one of the factors that affects the rate of market penetration, along with fuel costs and a host of other factors. He also indicated that the scenarios assume the build-out of hydrogen fueling stations (1,500kg/day) to support the vehicles, at numbers totaling 1,800, 4,000 and 8,000 stations by 2025 in Scenarios 1, 2, and 3, respectively.

Asked about the source of hydrogen, Dr. Gronich replied that all the stations are assumed to generate hydrogen at the forecourt (on site), mostly via steam methane reforming, which is equivalent to about \$2.50/gallon of gasoline (untaxed). Dr. Milliken added that the focus is on distributed natural gas for the early introduction of hydrogen infrastructure because this is the most mature, economical technology. She also noted that DOE has looked at the price and availability of natural gas and the impact of increased demand (estimated at less than 3%) for hydrogen fueling, and that this is not a major issue for near-term markets. Asked whether the modeling considered home reforming, Dr. Gronich replied that this option is

currently too expensive (\$7.00 to \$9.00/kg). He mentioned that the program has looked at "community reformers" (e.g. for neighborhoods or office complexes) that could co-produce electricity and hydrogen, and these might be economical.

Dr. Dresselhaus and Dr. Taylor questioned how this near-term infrastructure would lead to, or fit in with, the next generation of technology. Is there any concern about how this transition will occur and how the infrastructures might be related? Dr. Gronich noted that one of the big advantages of hydrogen is the ability to produce it in a number of different ways, so this opens the door to many different options for low-cost producers. Dr. Milliken pointed out that much of the technology developed for early markets (e.g., storage, hydrogen carriers for delivery, sensors and measurement devices, codes and standards, etc.) would be used in longer-term markets. Dr. Ramage asserted that the future would likely support a variety of production options, for example, regional production plants that supply urban clusters with distributed generation along highways or in remote locations. He suggested that the infrastructure needs to evolve, and that this is one way of starting it off.

Mr. Mudd asked whether carbon taxes or cap-and-trade programs were considered. Dr. Gronich replied that these were not considered for early markets, but that they could provide incentives beyond the transition. Mr. van Dokkum encouraged DOE to evaluate systems other than distributed methane reforming, so that we get some field experience with these systems and some visions of what the future could hold. Dr. Gronich replied that the Technology Validation program does include validations of distributed ethanol reforming and small-scale electrolysis.

Moving on with his presentation, Dr. Gronich described the initial urban fueling network for Los Angeles, which includes 40 stations (bumped up from 20 at the industry's urging), including some stations along highways to nearby locales; e.g., Las Vegas and San Diego. The analysis showed that, assuming a 3-mile radius for each station's customer base, you could reach 30% of the city's population with 40 stations. He presented a map of the country illustrating how infrastructure and corridors might get built out over time, and stressed that regionality may play an important role, based on the number of urban clusters, demand for fuel, local resources, etc. He presented preliminary results of some different cost sharing strategies and subsidies (50/50 cost share for infrastructure and vehicles and a 50-cent/kg tax credit), and explained how these would affect the different scenarios (while stressing that these results are preliminary and only a subset of the policy actions considered). Mr. Walker asked if the models include subsidizing or providing free parking in urban areas for hydrogen cars. Dr. Gronich said that they had not, but this was a good idea. He closed by saying that more information will be provided to the HTAC and to the NAS Committee as work proceeds, including information about the cost of the different scenarios and policy options.

Dr. Lloyd asked the Committee members how they thought these analyses affected their work. Dr. McCormick replied that he did not think it was so much the curves themselves that mattered, but what can be done to move the curves, and how rapidly, and whether this is something that the Committee wants to support. He stressed that it is also important to understand the magnitude of the investment required, and whether all players are willing to commit. Dr. Lloyd asked whether there has been any pushback on the plan to concentrate vehicles in New York and Los Angeles. Dr. Gronich replied that there has not been pushback among the limited audience who has reviewed it thus far.

A discussion ensued about the budget for the transition, and where the money would come from. Dr. Gronich replied that the scenario analysis would not address this—that it would have to be considered in next steps. Dr. Shaw expressed the opinion that time is of the essence, and that we have a precedent for applying large sums of money towards national priorities (e.g., \$160 billion for the post World War II interstate highway infrastructure). He asked whether even Scenario 3 is aggressive enough if we want to get serious about addressing global warming, since this is still only a fraction of the vehicles driven. He

asked whether the Committee could consider making some recommendations that go beyond a business-as-usual strategy. The industry representatives concurred that they could step up and respond to such an initiative, but that proper incentives would be needed to engage the best people in industry, supplier organizations, universities, etc. They agreed that without an economic incentive, industry will not tool up.

Dr. Ramage stated that power generation is a big contributor to carbon emissions, and suggested that the transition might look at some options for encouraging co-production of electricity and hydrogen power. He recommended that they take a look at the priorities the program places on stationary power and distributed power. Dr. Shaw suggested that a program such as Germany's feed-in tariff could provide a big incentive for stationary power, and that a briefing on this program could be useful. Mr. Mudd asserted that coal-based hydrogen with carbon capture and sequestration is one of the least-cost pathways towards producing hydrogen. He suggested that this could be a way to jump-start the supply of hydrogen, and he would be happy to prepare a presentation for the HTAC going into more detail.

X. Posture Plan Presentation and Discussion: 1) Accomplishments since 2003; 2) Major changes from 2003; 3) Milestones and timeline

Dr. Milliken, Acting Hydrogen Program Manager, began by introducing the representatives from the other offices that are involved in the Hydrogen Fuel Initiative. From DOE she introduced the following people: Mr. Lowell Miller from the Office of Fossil Energy (FE); Mr. Carl Sink from the Office of Nuclear Energy (NE); and Dr. Tim Fitzsimmons from the Office of Science (SC). From the Department of Transportation (DOT), she introduced Mr. William Chernicoff from the Research and Innovative Technologies Administration (RITA). It was also announced that the 2006 Hydrogen Posture Plan is now publicly available at <http://www.hydrogen.energy.gov>.

Dr. Milliken stated that her presentation describes the Hydrogen Posture Plan, which presents the Program's activities at a high level. More detail on all of the specific program areas can be found in each of the office's multi-year research plans. She emphasized that while a lot of time was spent this morning discussing infrastructure and market penetration, about 85% percent of the program is research and development. She noted that her presentation would highlight some key differences between the 2004 Posture Plan (the first version) and the updated, December 2006 Posture Plan that the Secretary just approved.

She described the DOE Hydrogen Program's organization, which involves the four DOE offices mentioned above, with the HTAC reporting directly to the Secretary. She noted that the current organization chart shows the Interagency Task Force (ITF) at the Program Level. As a result of the HTAC's recommendation, the DOE is currently taking action to elevate the ITF to the Assistant Secretary level. In this regard, she reported that DOE has contacted each of the members of the current Interagency Working Group and asked them to identify their organization's representative at this level. Assistant Secretary Karsner will then make contact with each person to establish the higher-level Task Force, and the current working group will support it.

Dr. Milliken pointed out that the bulk of the Hydrogen Program is within EERE's Hydrogen, Fuel Cells & Infrastructure Technologies (EE-HFCIT) Program because it focuses on so many of the cross-cutting and supporting activities. In the Production and Delivery subprogram, EE-HFCIT is investigating a number of different pathways to produce hydrogen, including near term methods for distributed production from natural gas, renewable liquid reforming and electrolysis. As longer term options, EE-HFCIT and other EE programs are conducting R&D on biomass gasification, central wind and solar electrolysis, solar high-temperature thermochemical, photoelectrochemical, and biological production.

She noted that hydrogen delivery R&D activities are currently concentrated on delivery of hydrogen at the forecourt (which involves technologies for bulk hydrogen storage, liquefaction, and compression, among others). Longer-term R&D will address delivery from centralized production approaches. She referred Committee members to page 29 of the Hydrogen Posture Plan for the detailed R&D milestones in all the subprogram areas and to the HFCIT multi-year program plan's target tables.

Going through the other subprogram elements, Dr. Milliken noted that EE-HFCIT has a very active hydrogen storage R&D subprogram, since that is one of the most significant technical challenges. Because much of the R&D is fundamental in nature, the subprogram's research is closely integrated with the Office of Science. Low cost, durable fuel cells is another key technical goal, and the Fuel Cells subprogram focuses R&D on materials and components to reduce cost and improve performance. She noted that the Manufacturing subprogram was included as a new start in the 2007 budget request; but with a year-long Continuing Resolution on the budget, this activity may not be funded in FY 2007. The focus of the Manufacturing R&D subprogram will be to bring the cost of technologies down through manufacturing economies of scale and to facilitate the development of a domestic supplier base. Dr. Milliken noted that EE-HFCIT intends to start the Manufacturing subprogram in 2008 with a solicitation. The remaining EE-HFCIT subprogram areas (Technology Validation; Safety, Codes and Standards; Education; Systems Analysis, and System Integration) would be discussed in later segments of the Posture Plan presentation.

Dr. Milliken reviewed the three overarching hydrogen program goals as identified in the Hydrogen Posture Plan. As mentioned previously, the more detailed R&D program milestones can be found on page 29 of the Posture Plan.

- 1) On-board hydrogen storage systems with a 300-mile range between fill-ups
- 2) Fuel cell system with cost and lifetime competitive with current vehicles (\$30 per kW and 5,000-hour durability)
- 3) Hydrogen production technologies that are competitive with gasoline on a cost-per-mile basis (\$2.00 to \$3.00 per gallon of gasoline equivalent)

Dr. Milliken introduced Mr. Lowell Miller, Director of the Office of Sequestration, Hydrogen and Clean Coal Fuels, in the Office of Fossil Energy, to provide an overview of DOE's coal-based hydrogen program. Mr. Miller began by making the point that the Fossil Energy Program, in total, is a very integrated program, and that many of the programs are synergistic. He called attention to several FE programs that are not part of the Hydrogen Fuel Initiative, but which are very supportive of its goals, for example, the carbon sequestration program, the coal gasification program, the high-temperature fuel cell program, and other reactor programs. Therefore, Mr. Miller explained that the program's first step as a part of the Hydrogen Fuel Initiative was to evaluate ongoing FE activities and where the real gaps were in addressing hydrogen production from coal, in particular. They identified two key technical hurdles for producing hydrogen from coal: 1) hydrogen purity and 2) overall system efficiency and cost. Mr. Miller briefly described the three R&D focus areas established to address these hurdles:

- Separations: multi-component gas-separation technologies
- Membrane Reactors: multi-step reactor processes
- Process Integration: process intensification to increase system efficiency

He identified the key coal-based hydrogen R&D program milestones:

- **FY 2008:** Small scale test system for separation of multi-component gases
- **FY 2011:** Membrane separation modules and reactors to meet cost targets of \$150 -200 per 200 per square foot

- **FY 2015:** Near-zero emissions plant producing hydrogen and power with carbon capture and storage that projects to a hydrogen cost of \$0.80 per gallon of gasoline equivalent (gge) at the plant gate (Currently estimated at \$3.00/gge, in \$2003)

Mr. Miller further noted that these goals and milestones are consistent with the goals and schedule of the FutureGen project, which is proceeding along a parallel path. Dr. Ramage asked whether the program could provide more information on the R&D status versus the targets. Mr. Miller replied that the program is currently on schedule to meet these targets, but he could provide additional information to the Committee on this at a later time.

Next, Dr. Milliken introduced Mr. Carl Sink, with the Office of Advanced Nuclear Research in DOE's Office of Nuclear Energy, to discuss the nuclear-based hydrogen program. Mr. Sink described the program's goal: developing high-temperature, greenhouse gas-free, hydrogen production technologies compatible with next-generation nuclear reactors that are being developed by the Generation IV nuclear research program. The two processes being explored are thermochemical systems (sulfur iodine and hybrid sulfur) and high-temperature steam electrolysis. He explained that both thermochemical processes use nuclear energy to produce process heat and electricity; require development of components that can withstand high temperatures and can operate in a very corrosive environment; and have a potential for high-efficiency, high-volume hydrogen production. In high-temperature electrolysis, Mr. Sink explained that an electric current is passed through high-temperature steam, and a membrane is used to split it into the hydrogen gas and the oxygen ions at an electrolyte later in the cell. He stated that the advantage of high-temperature electrolysis is its potential for higher efficiency than conventional electrolysis, which is generally around 25 percent. The efficiency of high-temperature steam electrolysis is projected to be around 50 percent. A third research area is focused on developing the components needed to interface with the hydrogen production technology at a nuclear reactor plant, in order to address interoperability and safety issues.

The nuclear-based hydrogen R&D program milestones include:

- **FY 2008:** Operation of laboratory-scale hydrogen production experiments
- **FY 2011:** Select hydrogen production technology for Next Generation Nuclear Plant (per EPAct)
- **FY 2014:** Operation of pilot-scale hydrogen production experiments
- **FY 2019:** Demonstrate commercial-scale hydrogen production system for use with nuclear reactors

Mr. Sink reported that lab-scale experiments are currently underway on sulfur iodine (General Atomics in partnership with the French CEA and Sandia National Laboratory) and high-temperature electrolysis (Idaho National Laboratory in partnership with Ceramatec). When asked by Dr. Shaw about the total expected cost for getting to the 2019 goal, Mr. Sink replied that he did not have the exact figures with him, but approximately \$100-million.

Dr. Tim Fitzsimmons, with the Office of Basic Energy Sciences, presented information on the basic research focused towards the Hydrogen Fuel Initiative within DOE's Office of Science. He described the goal as fostering fundamental understanding in hydrogen production, delivery, storage, and conversion technologies, with a focus on five critical basic research areas:

- 1) Novel materials for hydrogen storage
- 2) Membranes for separation, purification and ion and ion transport
- 3) Design of catalysts at the nanoscale
- 4) Bio-inspired materials and processes
- 5) Solar hydrogen

He reported that the first solicitation, run in FY 2005, was focused on these five areas and awarded \$21 million/year to 70 projects, distributed among approximately 25 states and 50 institutions. In FY 2007, the program issued a follow-on solicitation for about \$17.5 million/year, targeted towards projects addressing membranes, storage, and catalyst design for fuel cells. The program has received approximately 250 proposals that are in the process of being reviewed. Dr. Fitzsimmons stated that the award and funding of projects in FY 2007 will depend on the outcome of the Continuing Resolution. He thanked Dr. Sunita Satyapal (Team Leader for Hydrogen Storage Technologies, EE-HFCIT) and her colleagues, for their help in integrating the Office of Science's R&D into the Annual Hydrogen Program Review last May, and noted that this will occur again at this year's Program Review.

Dr. Milliken added that while all the projects in the Hydrogen Program's applied research program are reviewed annually at the Hydrogen Program Review, the Office of Science selects a subset of their research projects for presentation. This allows the applied researchers and the basic researchers to interact and collaborate. At this point Dr. Milliken introduced the Team Leads for the EE-HFCIT R&D subprograms who were present in the room: Dr. Sunita Satyapal (Team Leader: Hydrogen Storage), Dr. Nancy Garland (Acting Team Leader: Fuel Cells), and Ms. Roxanne Garland (representing Mr. Patrick Davis, Acting Team Leader: Hydrogen Production and Delivery).

Mr. William Chernicoff, with the DOT Research and Innovative Technology Administration (RITA), presented next on DOT's role and activities in the Hydrogen Fuel Initiative. He described the DOT's goals as ensuring a safe, reliable, and accessible transportation system and reducing the environmental impact from transportation. He portrayed DOT's Hydrogen Program as being composed, roughly, of two parts. The first is funded as part of the President's Hydrogen Fuel Initiative (HFI) in partnership with the Department of Energy. The second, larger, part of the DOT program is funded outside of the HFI, and includes fuel cell bus demonstration programs and other activities that have a direct connection to the HFI.

DOT's activities include R&D (through RITA) and regulatory activities, (through the National Highway Transportation Safety Administration [NHTSA] and the Federal Motor Carrier Safety Administration [FMCSA]), directed towards vehicle safety and standards. The NHTSA develops regulations for light-duty vehicles and the FMCSA develops regulations for medium- and heavy-duty commercial vehicles, including operational standards. Mr. Chernicoff noted that DOT has a long-standing relationship with the first-responder community and a history of providing education and training products on vehicles, infrastructure and HAZMAT transport, including code training for Fire Marshals. DOT is also doing heavy-duty fuel cell vehicle demonstrations, primarily as part of the Federal Transportation Administration's National Fuel Cell Bus Program (NFCB). Lastly, he noted that DOT is working with DOE on transportation infrastructure and systems analysis to better understand what sort of infrastructure might be required and what needs to be done to accommodate it.

Mr. Chernicoff identified three milestones for DOT's part of the HFI, adding that the timeframes presented are dependent on the FY 2007 Continuing Resolution and future budgets:

- **2008-2010:** First responder training program on hydrogen (courses taught at firehouses and academies)
- **2010:** National Fuel Cell Bus demonstration phase II completed
- **2012 (estimate):** Necessary rulemakings in place through NHTSA

He asked for feedback from the HTAC on whether the timing for rulemakings was in line with their needs and expectations, and any ideas on how the rulemaking process can be accelerated while still protecting public safety.

Mr. Bawden asked Mr. Chernicoff what kind of work is involved in the areas of “ensuring vehicle safety and standards.” (Is this up-front design inputs? Technology identification?) Mr. Chernicoff responded by saying that DOT participates in the development of consensus codes and standards, and conducts R&D to develop data that go into these codes and standards or the eventual rulemaking. He stated that DOT is involved with the Society of Automotive Engineers (SAE) Committees dealing with fuel cells, compressed hydrogen storage, electric drives, etc. DOT tests and evaluates components and conducts modeling to support analyses. Accident investigation and analysis is also a key part of building the knowledge base, but there is limited experience on this with hydrogen and fuel cell vehicles.

Mr. Bawden also asked how DOT measures the success of the first-responder training programs and why it takes two years to develop. Mr. Chernicoff said that the first step is to develop a credible training program. Then it is provided to the academies, college programs, and other training venues. The key measures of success are the number of personnel receiving the training and whether the training is being incorporated into curricula as a mandatory part of a first-responder’s training. He noted that it takes a long time to get two or three million people trained, and there is a long lead time to get it done. He pointed out that by the 2010 milestone, the expectation is that only a fraction of firefighters will have received the training; the goal is to have developed a curriculum and trained enough trainers so that by 2010 anyone who wants the training can get it in any of the 50 states.

Mr. Walker asked if thought has been given to training, in this 2008-2010 timeframe, the policymakers in the fire service who are involved in the decision-making about regulations (such as the Fire Marshals) as opposed to the first-responders themselves? Mr. Chernicoff agreed that this should be done, and added that DOT is working in coordination with the National Association of State Fire Marshals, both to develop the training programs and to incorporate the programs into the training curricula.

Mr. Chernicoff announced a recent Federal Register notice, which was published to “inform the public of current U.S. statutes and regulations that may be applicable to a hydrogen economy and to request comments on their interface.” The Notice (Fed Reg, Jan 5, 2007, v72, n3, 609-624) can be accessed at <http://www.hydrogen.gov/regulations.html>. (This website also has a list of all the legal authorities applicable to a hydrogen economy, sorted by transportation mode.) The effort to develop and issue this Federal Register notice was led by DOT-RITA, but includes 1-1/2 year’s work by the Ad Hoc Committee on a Regulatory Framework for a Hydrogen Economy (a subgroup of the Interagency Working Group on Hydrogen and Fuel Cells) to identify what regulations exist, who is responsible for what, and where the gaps are. Ad Hoc Committee members included representatives from OSTP, Dept. of State, DOT (including all relevant administrations), USDA, OSHA, EPA, NASA, and FERC. Mr. Chernicoff described this as a national milestone towards addressing the safety and regulatory issues that need to be in place to move forward. He urged the Committee to review the Notice and to provide any inputs during the public comment period, which closes on March 6, 2007.

Dr. Milliken notified the HTAC of the availability of an on-line training tool developed by the EE-HFCIT program as an introductory training product, and introduced Ms. Christy Cooper, who managed the effort as the Education subprogram’s Team Leader. When asked by Mr. Bawden how success of this training tool is measured, Ms. Cooper responded that the training is completely voluntary and that participants are asked to take a quiz at the end, the results of which are tracked by the program. Ms. Cooper also noted that the Program will measure success through a survey of the hydrogen knowledge of different audiences, including first responders and the general public, and comparing the results to those of the baseline survey completed in 2005.

Mr. Walker began a discussion of whether there is, or should be, a master “to do” list of sorts for reaching the overall goal—a functioning hydrogen economy. So that the actions (regulatory, etc.) needed are understood and agreed upon, responsibilities are defined, assignments are made, progress is tracked, and

success is defined. Mr. Chernicoff mentioned that DOT has done a gap analysis in cooperation with industry, but that it does not go to the level of a roadmap or action plan with defined dates. He also mentioned that NHTSA has a four-year R&D plan, but that progress on hydrogen-related pieces has been limited. The group agreed that this sort of effort goes beyond just DOT and DOE – it is something that needs to include all the agencies in a coordinated fashion. Dr. McCormick suggested that what is needed is a list of all the things that need to be accomplished across the different agencies—who is responsible? What is being done (or needs to be done) to address each issue? And what is the status? NREL's Dr. Jim Ohi (representing Patrick Davis, DOE Team Lead for Safety, Codes and Standards) mentioned that the Codes and Standards Tech Team (part of the FreedomCAR and Fuel Partnership) has completed a roadmap to develop the scientific and technical basis for the codes and standards required—and this could be used as input for a broader, “master list” of regulatory activities. He also mentioned that the Tech Team has developed a national template for codes and standards.

Dr. Milliken suggested that the next HTAC meeting include a briefing on ongoing Codes and Standards activities, which was seconded by members of the Committee. She also agreed with the HTAC's suggestion to task the Interagency Task Force (perhaps working through the Ad Hoc Committee on a Regulatory Framework for a Hydrogen Economy) with an action item to develop this “master list” or “action plan.”

Mr. Bawden remarked that there needs to be more urgency to this issue. He would like to see the necessary codes and regulations being developed within a matter of fiscal *quarters* rather than years. He asked what it would take to make this happen. The ensuing discussion pointed to the need for higher-level political involvement to shift the resources that would be needed. Dr. Milliken indicated that the elevation of the Interagency Task Force will bring these issues to higher-level decision makers within the government and will help in this regard.

Continuing on with the presentation on the Hydrogen Posture Plan, Dr. Milliken described the programmatic accomplishments since 2003, including several competitive solicitations that have awarded over \$640 million of Federal funding to R&D projects (about \$920 million with cost share). Several solicitations are currently ongoing, including one issued by the Office of Science, and one issued by EERE's Hydrogen Storage subprogram. She reported that the energy companies are now fully integrated into the FreedomCAR and Fuel Partnership, and emphasized the importance of the Partnership to the Hydrogen Program's success, especially the Technical Teams' help with establishing technical requirements and evaluating research progress and results.

Dr. Milliken briefly reviewed some of the key technical accomplishments since 2003, including:

- 1) Reduced the high-volume cost of automotive fuel cells to \$110/kW. She noted that this was achieved largely by reducing platinum loading and devising ways to better use platinum in the fuel cell. Asked about the definition of “high-volume” she explained that these are projected costs (on paper), based on expectations for costs with today's technology at production levels of 500,000 fuel cell systems/year. The actual cost today for making these units in a more “hand built” fashion is about \$3,000/kW. Dr. Ramage added that the industry members of FreedomCAR and Fuel Partnership help to develop the high-volume cost projections and the models on which they are based.
- 2) Reduced the cost of producing hydrogen from natural gas to \$3/kg, which is within our target range of \$2-\$3/kg. She noted that progress on cost reduction has also been made in the other distributed production technologies, including small-scale electrolyzers and reforming of renewable liquid fuels. When questioned, she noted that the natural gas reforming cost of \$3/kg is based on station sizes of 1,500.kg.

- 3) Achieved 2,000 hours (~60,000 miles) of fuel cell durability in the lab (DOE target: 5,000 hours or 150,000 miles)
- 4) Identified a number of new materials with higher hydrogen storage capacities, but issues remain to make these materials practical on a vehicle (temperature, pressure, etc.)

Dr. Milliken reminded the Committee that the key technical milestones for the Hydrogen Program are presented on pages 28-29 of the Posture Plan. She drew attention to the notations on the chart for milestone slippages (dotted lines), which mostly occurred because the program did not receive the funding that it planned and requested. She noted that the DOE Hydrogen Program has developed a work breakdown structure that identifies the R&D activities and projects (including budgets) needed out to 2015 to meet the goals and milestones. She stated that when the program has budget shortfalls, the funding for some projects has had to be delayed or reduced, and milestones along the work breakdown structure have had to be moved out. Dr. Ramage broke in to say that this is a very important issue for the Committee to consider, especially given the fact that the EERE program is heavily earmarked by Congress, especially in the hydrogen production area, where almost half of the budget is earmarked. He remarked that this throws the program out of alignment and has a very negative effect on the program's ability to operate effectively. Mr. Walker seconded this opinion, noting that he opposed earmarking during his tenure in Congress because he saw how destructive it was to science programs. Dr. Dresselhaus lamented that this is a difficult issue and one that is difficult to figure out how to address. Mr. Walker retorted that one key issue is whether the earmarks actually contribute to the substance of the program or not. If so, then this may be viewed as a way for Congress to provide some rational input on a program; if not, then this is destructive to the program's goals. Dr. Milliken agreed with Mr. Walker that there is a need to balance enthusiasm for the program and the urge to get involved (by Congress and other stakeholders) with the need to focus R&D funding on the Program's well-laid plans.

Continuing discussion on the effects of budget shortfalls on milestones, Dr. Milliken noted that when the program receives a lower budget than it requested (usually a result of both appropriations shortfalls and earmarks), the program looks at what is absolutely needed to meet the 2015 technology readiness goal--the critical-path technologies. She noted that these are the areas for which funding is maintained. Funding for longer term projects, like centralized production and delivery, is reduced or delayed. This is why some milestones in some programs (like Production and, especially, Delivery) have been delayed while others (like Storage) have not. The Fuel Cells milestones have largely remained on track, since this is a high priority, except for the area of distributed stationary power generation. She reported that Technology Validation is also a high priority, and has been received favorably in the appropriations language. Dr. Milliken stated that the Education and Safety, Codes and Standards areas have not been funded at the level that the program would like, because these are two areas that get hit. The reason for this, she explained, is that the program believes it is more important to meet the technical goals in the R&D programs. For the same reason, some Systems Analysis work has also been delayed. When asked how the Continuing Resolution will impact the program, Dr. Milliken said that once the 2007 budget is decided, they will need to assess how it impacts the key activities and milestones. She added that the program has been able to maintain its overall goal of achieving technology readiness by 2015, but that a 2006 budget level with earmarks would make that difficult to achieve.

Dr. Milliken presented the Hydrogen Program budget and reported that the FY 2006 appropriation was \$232.5 million, which included \$47.5 million in earmarks (mostly in the EERE portion of the budget). She presented the budget breakdown among key activities, and noted that the distribution among activities does not change much between the FY 2006 budget and the FY 2007 request of \$289.5 million. Within Production and Delivery, production activities were funded at \$74 million, with the largest share going to distributed renewable technologies (electrolysis and renewable liquids reforming), and delivery was funded at \$7million. The Posture Plan also describes supporting R&D funded by programs outside the Hydrogen Fuel Initiative, and Dr. Milliken presented a slide showing funding in these areas (e.g.,

hybrid electric vehicles and advanced batteries, carbon sequestration and carbon management, biomass energy and biorefinery systems, wind and solar energy, high temperature stationary fuel cells, basic research on biological hydrogen production, and DOT's fuel cell bus R&D).

Dr. Milliken turned to the subject of program updates described within the Posture Plan. She described the modifications to the illustration of the scenario "timeline" for technology development and market transformation, which changes the terminology used for the program's 2015 milestone. The milestone was changed from a "commercialization decision" in 2015 (which some found confusing, since this is not DOE's role) to "technology readiness." The illustration was also modified to clarify that the initial market penetration of these technologies is actually going to take place over a period of time rather than a point in time.

The hydrogen cost goal has also been changed, and a discussion of this is provided in the Posture Plan. Dr. Milliken stated that the initial hydrogen cost goal of \$1.50/kg (or gallon of gasoline equivalent, gge) was established early on in the program, and was based on the cost of gasoline at the time. The new cost goal, established in 2006, is \$2.00-3.00/kg (delivered, untaxed) in 2015. The goal was established using Energy Information Administration forecasts for the 2015 cost of gasoline and the forecasted fuel economy of fuel-cell vehicles compared to gasoline vehicles (2.4x) and gasoline-electric hybrid vehicles (1.6x). She noted that since this is a *delivered* cost, the total production cost must take into account any hydrogen delivery charges (e.g., trucking, compression, storage, etc.).

Dr. Milliken described progress in a number of new program areas that were started after the first version of the Posture Plan was written in 2003. One of these is the progress in learning demonstrations, which are currently operating with 10 fueling stations and 63 fuel cell vehicles (moving up to 19 fueling stations and 131 fuel cell vehicles over the next several years). Dr. Milliken reported that the data coming out of the demonstrations have been invaluable to learning about the real-world status of this technology. Another outcome is developing experience with safety issues and a track record of use. She reported that so far no major safety problems have been encountered.

Dr. Milliken briefly reviewed progress described for some of the other new activity areas, including: Manufacturing R&D, Safety, Codes and Standards, International Partnership for the Hydrogen Economy, Systems Analysis, and Systems Integration. She noted that the well-to-wheel analyses included as Appendix B of the Posture Plan were developed using the new H2A and updated GREET models.

Mr. Wooten asked if the well-to-wheel analyses are used in setting program priorities. That is, if an analysis indicates that (even with technological developments envisioned for the future) a pathway cannot meet the milestone, then would this pathway be eliminated? Dr. Milliken replied that none of the pathways have been eliminated yet, and that this is a bit tricky, because some of the pathways will not mature until well beyond the 2015 goal of \$2.00-\$3.00/kg, so it may not be fair to hold them to this goal. The long-term goal is for hydrogen to be produced from diverse domestic resources, some of which may not come into play in the market until much later. Dr. Milliken went on to explain that the (EERE) programs that are longer term in nature are the ones that wind up getting their funding delayed. She added that there have been some discussions about dropping the pathway on grid-assisted wind, which does not appear to hold much promise on a well-to-wheels basis.

The Systems Integration activity was begun as a result of a recommendation by the National Academies, to provide a systems approach to program management. Dr. Milliken noted that this activity includes a rigorous change control program that systematically looks at what happens when the program changes a target—how does this impact other targets, future milestones for that particular subprogram and for the hydrogen program overall? This activity also manages the 2015 work breakdown structure that was mentioned earlier, as part of establishing an integrated baseline to measure progress. She also called out a

critical function of Systems Integration, which is to conduct independent assessments of critical targets and program decision-making milestones. An independent assessment of EE's polymer electrolyte membrane (PEM) fuel cell cost analysis validated the accuracy of the results and the underlying assumptions. The cost of producing hydrogen via distributed steam methane reforming was also validated through independent assessment in 2006. In 2007, assessments will be conducted on cryogenic compressed hydrogen and on distributed reforming of renewable liquids.

Questions and Discussion on the Posture Plan follow.

Dr. Shaw asked about the Secretary's response to the Posture Plan, the issues that he raised, and Dr. Milliken replied that he did not raise any issues in particular. In response to a question about why the document was named the "Posture Plan," Dr. Milliken replied that this was an artifact of the terminology used in the request from then-Undersecretary Robert Card for the first version of the report. The name has just stuck with it, though it could be changed.

Mr. Mudd asked whether any thought has been given to conducting a value analysis, or earned value management, to look at the funding versus the value of the different programs to see if there is a good match. Dr. Milliken replied that this is an activity that is planned for later this year.

Dr. Dresselhaus reported that the professional societies are expressing positions to Congress on how the Continuing Resolution should be resolved, and urged interested members of the research and scientific community to get in touch with their professional societies to support this effort. Dr. Lloyd and Mr. Walker suggested that while the HTAC, as a group, might not be able to write to Congress expressing an opinion about limiting the use of earmarks, this could be done by HTAC members as private individuals or company representatives.

XI. Review of 2007 Posture Plan: high-level comments from HTAC members

Mr. Walker (HTAC Co-Chair) asked each HTAC member to provide brief, high-level comments on the Hydrogen Posture Plan. He explained that these comments will be used by the Subcommittee on the Posture Plan in formulating their recommendations and next steps.

Mr. Walker started off by stating that writing the Posture Plan represents a delicate balancing act among competing audiences and requirements for its content: EPACT, Congress, Office of Management and Budget, DOE management, etc. The Plan describes a lot of deliverables, which is likely what Congress wants to hear, but he cautions that deliverables should not be confused with objectives, and with actual progress towards meeting the objectives. He asked the rest of the Committee members to consider whether the Hydrogen Program should be an evolutionary program, or a revolutionary program. And if we would, as a group, recommend an approach that fosters more revolution rather than evolution. He also asked the group to consider if it would suggest a higher level of risk than what was described in the Posture Plan today.

COMMENTS ON THE HYDROGEN POSTURE PLAN

Mr. Greg Vesey, Chevron Global Power Generation: Mr. Vesey stated that he is very supportive of the Plan and its stated goals. He supported an evolutionary rather than a revolutionary path forward. He agreed with the approach to foster a diversity of hydrogen supply pathways, in spite of its difficulty to manage. He also expressed agreement with focusing a large percentage of the budget on R&D at the component level. He added that Chevron's participation in learning demonstrations has been extremely

valuable. He supported the need for manufacturing R&D and said that this will help to lower costs for fueling stations.

Mr. Michael Mudd, FutureGen Alliance, Inc.: Mr. Mudd stated that the breakthroughs needed are important from a national level, so he supports the revolutionary as opposed to the evolutionary tone. He agreed that the Plan should definitely focus on R&D. He reiterated what he views as a shortcoming in the Plan: the lack of value analysis. He pointed out that it appears that renewables are receiving about four times as much funding as coal-based hydrogen, yet this appears to offer the lowest-cost pathway for producing hydrogen. He conceded that there may be other reasons for this distribution of funding, but that a value analysis would help to justify the position.

Mr. John Wooten, Consultant to Peabody Energy: Mr. Wooten agreed that it is a good Plan. He expressed his opinion that the HTAC can help by assisting the Secretary and the Program in de-selecting. He stated that right now the program is very broad, and that with budget constraints there may be a need to de-select some of the pathways that do not look likely to meet the cost goals, even if R&D is successful. He suggested that the next Posture Plan include analyses that will help to set priorities in times of budget shortfalls so that budgets are apportioned to the highest-value programs.

Dr. Michael Ramage, ExxonMobil Research & Engineering (Retired): Dr. Ramage stated that he likes the Posture Plan, and suggested that the Plan should contain both evolutionary and revolutionary ideas, which he thinks it does. He explained that with an uncertain and unknowable future, evolution is necessary, but that research breakthroughs are also needed to reach a carbon dioxide-free economy. He expressed worry that the R&D on the longer-term needs is being pushed out. He agrees that there is a need for setting some priorities and for including more "go/no-go" decision points. He commented that DOE should focus on areas that industry will not pursue on its own. Dr. Ramage also conveyed his opinion that it will not be a "hydrogen future"—but rather a future in which energy is provided by diverse sources. He stressed his recommendation that the Plan provide more emphasis on the power generation side, specifically, power generation using hydrogen-powered PEM fuel cells. He expressed the need to describe synergies and benefits that can arise from stationary fuel cells combined with a hydrogen fueling infrastructure.

When Dr. Ramage mentioned budget issues associated with stationary fuel cells, Dr. Milliken questioned whether he was referring to the Senate appropriations mark, which zeroed the budget for distributed stationary PEM fuel cells. He replied no, that he was just emphasizing that the hydrogen economy is not only vehicles, and that a broader scope is needed. He expressed support for the R&D directed at reducing the cost of PEM electrolysis, stating that this could become the real route to renewable energy.

Mr. Art Katsaros, Air Products and Chemicals, Inc.: Building on the earlier point, Mr. Katsaros stated his opinion that hydrogen is one of many alternatives to reduce the dependency on foreign energy. He suggested this idea be used as a touchstone in the Committee's evaluations. He agreed that the Plan is good and stated that it is very comprehensive. He supported the recommendation to prioritize, and recommended a focus on fewer things. He held out the 2004 report from the National Academies (*The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs*) as a valid roadmap for selecting priorities. He stated that it is relatively easy to build a lot of hydrogen production capacity from conventional hydrocarbon resources, and does not see this as an issue. He suggested that a critical focus issue for the Posture Plan should be how to do this as efficiently as possible (e.g., geographic focus, etc.). He strongly suggests that the Posture Plan be explicit in its recommendation of a geographic focus, with a key benefit of this approach being the ability to better manage and deal with the code and permitting issues.

Mr. Ian Purtle, Cargill, Inc.: Mr. Purtle agreed that there are likely to be diverse solutions to the energy dilemma that we face. He personally sees solar playing a much bigger role, given some of the recent breakthroughs. He stated his belief that ethanol will play a key role in the transition, and, perhaps, going forward. He said that the Posture Plan itself is well-designed and well-coordinated, but agrees with the need for prioritization. He believes that the biggest roadblock to commercialization of fuel cells is going to be the fragmented regulatory environment that industry faces, and urges the HTAC to address this.

Dr. Kathleen Taylor, Consultant: Dr. Taylor expressed her general agreement with the views communicated to this point. She expressed her opinion that the HTAC should consider the optimum application of the various sources of energy that could potentially be developed in the years ahead (even beyond hydrogen), in order to consider whole energy picture. She agreed with the Plan's focus on R&D. She cautioned against over-focusing on cost targets, because this can disguise the need for a discovery or a technology breakthrough. She supported the comparisons to competing technologies, and urged that this approach continue to include forecasts of technology improvements

Mr. Dan Keuter, Entergy Nuclear, Inc.: Mr. Keuter stated that the Posture Plan provides a good summary and provides good targets, but that the "devil is in the details." He expressed concern with the assumptions used in the well-to-wheels analysis of the nuclear pathway in Appendix B—some of the cost estimates appear to be too high. He also expressed concern that there are not more synergies identified among the different production pathways (for example, selling oxygen produced at nuclear hydrogen production facilities to coal-based plants that need the oxygen for their process). He suggested that a subcommittee(s) be formed to evaluate the production pathways.

Mr. John Bresland, U.S. Chemical Safety and Hazard Investigation Board: Mr. Bresland stated that he was impressed by the breadth and the complexity of the Posture Plan. He stressed the complex and convoluted nature of codes in the U.S., where each location has the liberty to develop their own codes. He conveyed his opinion that this will be a difficult issue to address. He suggested that communications and outreach is also important, to make sure that people understand that hydrogen is safe. He expressed his desire for a presentation on climate change and carbon dioxide emissions, and what sort of research is being done to address this. He also sees a need for standardizing the metrics on all the different types of energy. (For example, what is the value of a gallon of ethanol versus a pound of hydrogen versus a windmill in West Virginia?)

Mr. Jan van Dokkum, UTC Power: Mr. van Dokkum offered compliments on a good, comprehensive Plan, and was happy to see some of the updates since the 2004 version. His key criticism is that the Posture Plan does not address stationary power. He strongly recommends that the Plan expand its scope to include fuel cells in other applications besides automobiles. He also recommends that the Plan do a better job of communicating "why hydrogen." What, specifically, are we trying to achieve by going after hydrogen as one of our major energy carriers and why is this important from a national perspective? (Energy? Emissions? Global warming?) He asserts that this needs to be clearly articulated in order to drive the policy changes that are needed to facilitate commercialization. He strongly recommends adding to the Posture Plan a discussion of the government's role in commercialization. What can the government do in procurement, etc.?

Professor. Mildred Dresselhaus, Massachusetts Institute of Technology: Dr. Dresselhaus commented that she was pleased to see the Posture Plan's emphasis on collaboration between basic and applied research. She added that each of the five technical areas called for in the basic science solicitations was specifically addressed within the sections on R&D. However, she said basic research should be expanded into other areas such as Safety, Codes and Standards, or Education. Dr. Dresselhaus highlighted nanoscience and nanotechnology as key enabling areas of the hydrogen economy that are implicit in the plan. She asserted that explicit attention should be given in the next Plan to the next steps

of transforming nanoscience into applications. Nano-sciences blur the boundaries between the different disciplines and will require rethinking collaborative work from lab scale to demonstration and scaleup and the relationship between science and engineering. She asserted that this requires a multidisciplinary approach to R&D, which links the science with the engineering community.

Mr. James Reinsch, Bechtel Nuclear: Mr. Reinsch stated that he did not disagree with any of the previous comments. He remarked that the HTAC has an obligation, or at least an opportunity, to help the Secretary of Energy develop a vision for where hydrogen fits into the overall plan for national energy security and sustainability. He also expressed concern that the Posture Plan is not offering any ideas that are revolutionary—he classified it as incremental in nature. He urged the HTAC to consider opportunities like Price-Anderson or other pieces of legislation that have allowed people the ability to leapfrog incremental change. He further urged the Committee to go beyond “tactical minutia” and get involved in the policy area to make sure that the Committee addresses issues like: Why hydrogen is important? Why we should drive the states’ programs? Why we need international collaboration? What we need Congress and the Administration to do to make this happen? Who is the champion?

Dr. Roger Saillant, Plug Power: Dr. Saillant agreed with others who suggested that the Posture Plan expand its scope to include all three sectors. He supports the idea of promoting a parallel path to reduce energy consumption and improve energy efficiency at the same time. He speculated on whether the experience gained in Iceland could be applied in Hawaii. He suggested that the sense of urgency is missing in the U.S., and that this could be an area where the HTAC has some influence. Finally, he stated that the HTAC could take this as an opportunity to think about how a hydrogen economy might look very different than the one we have now. He urged the Committee to think about this not just as a one-for-one replacement of what we already have, but how we could change and do things differently (such as distributed power generation in homes).

Mr. Mark Chernoby, DaimlerChrysler: Mr. Chernoby stated that the Hydrogen Posture Plan is a good piece of work as an “integrated research, development, and demonstration plan.” However, he proposed that it needs to be “a comprehensive roadmap charting the energy plan for our nation, including objectives, research, development, demonstrations, and policy.” He believes that the Infrastructure and Scenario Analysis work that DOE is doing starts to touch on this, but that it just scratches the surface. He presented the elements done well in the current Plan, including technology objectives tied to market value; research program aligned with gaps and linked with industry partners; alignment with national objectives to reduce dependency on foreign oil and its impact on the environment; recognition of the need for government to support the full “development” timeline; and continuing support for critical work on codes and standards and communication. He cautions that actually achieving the objectives for reducing oil consumption and greenhouse gas emissions will require huge technology shifts in both the transportation and power generation industries, and that this will require a huge capital investment by the industry and a strong value proposition for customers. Mr. Chernoby asserted that what is needed is a very comprehensive scenario plan, with the following characteristics:

- Must start from the top down, with goals for reducing greenhouse gases and oil consumption
- Include scenarios which achieve objectives
 - Focus on areas with greatest impact—transportation/electrical production
 - Think beyond hydrogen—especially in early stages
 - Alternative fuels made from grain/biomass
 - Nuclear power
- Define alternative implementation plans that maximize the potential to achieve roadmap objectives, with critical thinking about:
 - Reasonable return on capital for industry/financial sector
 - Managing external variables, which could impact probability of return
 - Total cost of ownership makes the new technologies the obvious choice

- Policy
- Communication of intangible benefits (society, foreign policy, etc.)
- Plans must have a “Who does what and when?” level of detail

He stated his belief that DOE should take the lead on this, which may require empowering the agency beyond its current scope, with co-champions in the other affected agencies: DOT, DOC, EPA, NHTSA, and DOD.

Dr. Robert Shaw, Arete Corporation: Dr. Shaw stated that the Posture Plan was very well written, very clear, and very focused. He supported the comments made earlier by others that it does not go far enough, declaring that he would prefer to see more of a “moon shot” approach. He emphasized that an R&D program of \$250 million per year (the amount that a modest venture capital fund might spend) is well below what he would expect from the richest, most powerful government in the world addressing a global problem. He claimed that one of the best ways to learn is from markets, and encouraged directions that would lead to more products in the consumer market, even emerging products that are not completely “perfect.” He pointed to manufacturing as an enormous part of the problem, since high yields are needed to make the economics work. But, he noted, work in this area will be quite costly. Finally, he expressed a need for more data-gathering on what products (particularly in the stationary and portable areas) are in the market or about to go to market, especially internationally, so that we are not embarrassed by setting goals that have already been surpassed. He expressed concern over whether industry was already ahead of the Plan.

Dr. Milliken replied that in their partnership with industry, DOE tries to get as much industry input and feedback as possible. She noted that protection of intellectual property limits how much information industry is willing to divulge about their internal R&D. She added that proprietary data from the learning demonstrations is provided to DOE by individual companies and then put into "composite" form to share with the public. She agreed that more efforts are needed to collect performance data in the portable and stationary areas.

Mr. Larry Bawden, Jadoo Power Systems: Mr. Bawden remarked that the hydrogen economy is much bigger than DOE, so it would be good to see a commitment similar to DOE’s from other relevant agencies. He recommended that the Posture Plan be renamed something more like the “Hydrogen Economy Implementation Plan” and that it really include all the agencies who need to play a role.

Dr. Byron McCormick, General Motors Corporation: Dr. McCormick noted that the sense of urgency he hears—in the press, in the lunchroom, and from the floor of Congress—about the looming problem of global warming is not reflected in the Posture Plan. He also picked up the earlier comments about nanoscience, declaring that “we are in the age of designer materials.” He supported funding more high risk research that could lead to real breakthroughs rather than incremental improvements. He cited the need for higher levels of program funding so that basic science could be funded alongside necessary work in areas like applied R&D, education, and codes and standards.

The January 9, 2007, session was adjourned at 6:08 p.m. EST.

JANUARY 10, 2007 – MORNING SESSION

The meeting of the Hydrogen and Fuel Cell Technical Advisory Committee (HTAC) was called to order at 8:00 a.m. EST by Dr. Alan Lloyd, HTAC Chairman. Twenty of the 25 HTAC members were present (list attached); members not in attendance included Dr. Uma Chowdhry, Dr. David Friedman, Mr. John Hofmeister, Mr. Randall Napoli, and Dr. Craig Venter.

I. Opening Discussion from Committee Members

Dr. Milliken thanked the Committee members for their feedback on the Hydrogen Posture Plan the previous afternoon. She noted that DOE would follow up on the specific suggestions that were offered, such as Dr. Dresselhaus' recommendation to expand basic science into additional areas, and other members' suggestions to highlight the importance of work in Safety, Codes and Standards, and Manufacturing. She identified several recurring themes in the HTAC's over-arching recommendations on the Posture Plan. One concern was that the Posture Plan ends at RD&D and does not address how to move from this stage to the market or how to overcome market barriers. Another theme was that the current Plan is weak in its treatment of stationary and portable power applications and the corresponding synergies with transportation applications. A third, higher-level, recommendation from the Committee was that the Plan needs more interagency input; that it needs to be a national (rather than a DOE-focused) plan. She expressed her belief that this will be a major undertaking by the new Interagency Task Force that is created. Dr. Milliken stated that DOE finds all of these recommendations valuable and will follow up on many of them.

Dr. Milliken proceeded to offer some additional information and clarification about how DOE works in partnership with industry to establish R&D priorities and establish technical targets. She described how the FreedomCAR and Fuel Partnership operates, in terms of structure, organization, and management, as follows:

- The Executive Steering Group is at the top of the organizational chart; it includes Vice Presidents from the automobile companies and energy companies, as well as the Under Secretary of Energy (formerly Mr. David Garman). This group meets on an annual basis to address high-level issues, review progress, and chart high-level next steps.
- Beneath this steering committee are the Fuel Operations Group, comprised of Directors from the five energy companies, and the FreedomCAR Operations Group, comprised of Directors from the three automobile companies in USCAR. These groups have bi-monthly teleconferences and a few face-to-face meetings each year. These two groups also meet monthly as a Joint Operations Group to exchange information and coordinate activities.
- At the base of the Partnership's organizational structure are the 11 Technical Teams, which are made up of technical staff from the participating organizations. The Tech Teams meet on a monthly basis, and provide input to the R&D requirements and targets, review research results, and assist in evaluating progress towards research targets.
- The six Vehicle Tech Teams (which include partners from USCAR companies and DOE) include Fuel Cells, Advanced Combustion and Emissions Control, Vehicle Systems Analysis, Electrochemical Energy Storage, Materials, and Electrical and Electronics. The three Fuel Tech Teams (which include partners from the energy companies and DOE) are Hydrogen Production, Hydrogen Delivery, and Fuel Pathway Integration. The remaining two are "joint" Tech Teams, because they include members from both the energy and the USCAR companies. These are the Codes & Standards Tech Team and the Hydrogen Storage Tech Team.

Dr. Milliken noted that the Fuel Partnership has an active role in making sure that the program is on track and in helping to make recommendations about which projects need to end and which projects need to move forward. She stated that the FreedomCAR and Fuel Partnership focuses on the automotive side;

there is not a comparable partnership on the stationary and portable side. However, she noted that DOE does host workshops with the stationary and portable industry in order to gather feedback and input on R&D priorities and technical targets. She added that more efforts are needed to gather input on R&D needs and targets in the areas of fuel cells for telecommunications and back-up power; the main focus thus far has been on prime power and consumer electronics. Dr. Ramage reminded the HTAC that the scope of the FreedomCAR and Fuel Partnership includes both transportation-related activities within the Hydrogen Fuel Initiative, as well as the \$85 million directed towards advanced vehicle technologies, which includes hybrids, plug-in electric vehicles, batteries, advanced combustion engines, etc.

Dr. Milliken sensed that some people believe there is a disconnect between the DOE timeline and the automobile companies' timeline for vehicle market penetration. She does not think there is a disconnect, and reminded the Committee that, as originally conceived, the Hydrogen Fuel Initiative is directed strictly towards achieving R&D success; it does not include policies and incentives to accelerate market introduction. She explained that this is why the DOE timeline is 2015 for technology readiness and 2020 for vehicle market penetration. She offered her observation that the timeline presented at yesterday's meeting by the *ad hoc* industry group does include policies and incentives to accelerate the pace of market introduction.

Dr. McCormick replied that the timeline presented by the *ad hoc* industry group represents consensus on what the industry members think is possible based on today's technology and current designs for 2010 vehicles. He underlined that the timeline was not created from a bottom-up academic study, but rather from a "what-people-are-thinking-about" type of process. He emphasized that while industry has the "technical confidence" that it can achieve the timeline, actually achieving the timeline will depend heavily on a lot of other conditions; thus the schedule is not a commitment. He asserted that the timeline depends, among other things, on the assumption that the industry will have a partner in the government and that the general movement of the industry will be towards fuel cell vehicles in response to societal goals. He added that if he was presented with a curve that showed only 1,000 vehicles per year by 2025, he would have to tell his management not to invest in the project. Mr. Chernoby supported the basic message, which is that the automobile companies collectively agree that some aggressive policies and incentives will need to be in place in order to allow the industry to ramp up production fairly quickly; if not, there may not be a viable business case in the U.S. Asked by Mr. Walker whether these policies and incentives would need to be similar to what is occurring in Europe, Mr. Chernoby agreed that similar approaches would be needed to make it happen.

II. Reports from the HTAC Subcommittees

Subcommittee on the Hydrogen Posture Plan

Mr. Walker began by stating that the Subcommittee agreed that the Hydrogen Posture Plan was not intended to represent the overall "hydrogen plan" for the country. Rather, the Posture Plan represents DOE's evaluation of how it integrates hydrogen-related R&D within its own programs (and in collaboration with DOT). He noted that the HTAC has a different assignment, which includes considering the general policy framework, and, potentially, recommending policies that might drive this forward—an activity that is not within the DOE purview. Rather, DOE must work with the policies that are in place and the R&D assignments that they have been given. Therefore, he noted that the Posture Plan that HTAC reviewed and discussed yesterday is the DOE's outline of what the Department is able to do within the current landscape of resources and policies.

Mr. Walker reported that the Subcommittee's discussions thus focused on how to move beyond that, towards something designed to provide an overall "national hydrogen action plan." The Subcommittee

proposed that the HTAC take this to the Assistant Secretary-level Interagency Task Force as an action, once it is established. HTAC, he continued, would then ask for a report back from the Interagency Task Force that would look at hydrogen in a more comprehensive fashion. The Subcommittee recommended that the national hydrogen action plan accomplish three key things: 1) reflect the overall policy and priority; 2) cover all Federal department/agency activities (including Treasury/IRS and Department of Education); and 3) address the Posture Plan's limitations. He presented the particular limitations of the Posture Plan that need to be addressed within the action plan:

- Only addresses the hydrogen and fuel cell program specific to the President's Hydrogen Fuel Initiative – the transportation-related efforts are confined to DOE and DOT.
- Does not address hydrogen in a broader energy perspective—how it relates to other national energy plans.
- Assumes no policy support, and therefore the Plan's goals, technical targets, and schedules are not reflective of a comprehensive national strategy about what the plan would look like.

Mr. Walker stated that the intention would be to task the Interagency Task Force with providing the action plan to HTAC in time for the Committee to review it and use it in making their recommendations to the Secretary (in their October 2007 report), and, through the Secretary, to Congress. Dr. Lloyd noted that meeting this schedule would require a focused and concerted effort on the part of the Interagency Task Force.

In the ensuing discussion, the Committee agreed to put forward a resolution recommending the action described above for the Interagency Task Force. The group further resolved to recommend that the Task Force be expanded to include the Department of Treasury (Internal Revenue Service) and the Department of Education.

Dr. Saillant asked whether the HTAC should put forward a recommendation for the designation of one ultimate decision-maker for "all things hydrogen" within the Federal government (a hydrogen "czar"). Mr. Walker replied that although the HTAC could make such a recommendation, this would require congressional action and there is a general reluctance to do this because of negative experience with past "czars." While agreeing on this general point, others asserted that clear lines of accountability and responsibility are desirable. Mr. Walker commented that, given the bifurcated nature of Congress and the way the Federal government operates, the most efficient path towards creating effective policy may indeed be through the Interagency Task Force. He explained that the Task Force members could each then "own" a piece of the hydrogen pie, and then take this to Congress in their budget requests to show how it fits into an overall plan. Dr. Saillant noted this opinion, but reiterated his desire for clearer lines of accountability.

Dr. Ramage asked if this discussion was referring to policies to bridge the so-called "valley of death." He noted that eventually fuel cell vehicles have to compete with hybrids and other alternative vehicles on a cost basis, and the Committee has not spent a lot of time examining the likelihood for overcoming all the technical hurdles, some of which may require major technical breakthroughs to surmount. Dr. McCormick vehemently disagreed with Dr. Ramage's assessment of the severity of technical barriers. Continuing on, Dr. Ramage explained his position that the Committee should be very clear that its policy recommendations, whatever they may be, are for the purpose of getting through the transition, and not for the long term. He also expressed concern that hydrogen fuel vehicles may not turn out to be the only vehicle of the future, and so transitional policies are needed. He added that while many may support the notion of policies and incentives for the transition, many people will not support funding that has no end. He articulated that he is not advocating that the HTAC change its position to include policy as part of its purview; rather, he offers this point of view as something for the Committee's consideration in crafting its final recommendations.

Mr. van Dokkum supported a “transitional strategy” towards policies and incentives, adding that this would add to the credibility of the recommendations. He expressed his opinion that the real trouble spot in shifting towards a hydrogen economy is the transition—after this point business will take over on its own.

Dr. McCormick raised an issue to the Committee and asked if there was a way to communicate more information to the Committee on the actual status of today’s fuel cell system technology. He stated that cars being tested in today’s demonstration programs represent 6-year-old data and are not necessarily representative of [the automobile companies’] forward-thinking about what their current technology can do. He believes that it would be very useful for the Committee members to have a better understanding of this, but that much of the information is confidential and not in the public domain. He inquired if there are ways that industry could inform the Committee more without violating any of the rules of the Federal Advisory Committee Act (FACA).

Dr. Lloyd suggested that the Committee members keep in mind the sense of urgency involved, and the need to work quickly towards producing meaningful recommendations for this Administration. He added that all of the Committee members were selected for their expertise and integrity, and that should help in accepting each other’s assertions, without the need to “touch it to know that it’s there.”

Dr. Shaw supported the position put forward by Dr. McCormick, and agreed that the Committee’s discussions should reflect the reality of today’s marketplace. He postulated that the private sector—both domestically and internationally—is farther ahead than is widely understood because of the need to protect intellectual property and proprietary information. He agreed that Nobel Prize-winning breakthroughs are not needed to solve the remaining technical challenges and expressed his opinion that the Committee should not get too hung up on technical barriers.

Mr. Walker pointed out that the Subcommittee on the Posture Plan was in general agreement that there would be a diversity of energy supply for at least the next half century, and that there would be a number of competitive energy supplies (including hydrogen, gasoline, biofuels, battery-powered electric drives, etc.). He noted that hydrogen has an advantage in the longer term, because it offers so much flexibility as an energy carrier.

Dr. Milliken pointed out that DOE does interact with foreign companies (e.g., Toyota, Nissan, and Honda) in annual meetings and that public information is shared. She also noted that the International Partnership for the Hydrogen Economy convened an international conference on storage where information on fairly competitive research was shared. So there is some ongoing international information exchange on technology status.

Mr. Katsaros stated that the technological challenges are not just around fuel cells—there are also challenges associated with producing low-cost hydrogen product from renewables. He stated that because hydrogen must be produced in what is often a multi-step process, that there are losses along the way that may make it less efficient on a well-to-wheels basis than Btus from petroleum or natural gas.

Mr. Mudd proclaimed that what is needed is an analysis of where the real shortfalls are, and how the government can help. He asserted that the government should stay out of areas that industry has under control. Mr. Chernoby warned that there is still a lot of work to be done to reach the technical goals for automotive fuel cell technology, as is outlined in the Posture Plan. He stated that breakthroughs are needed to get to the point where hydrogen fuel cell vehicles can be offered at a low-enough cost to replace the low-cost vehicles offered today.

Dr. McCormick stated that as research progresses, the R&D priorities change. He described the example of platinum loading for fuel cells, saying that that problem of reaching low-platinum loadings is close to being overcome. But as that problem is solved, the focus becomes zero-platinum catalysts using designer materials, nanostructures, organometallics, and so on. He supported the government's role in high-risk R&D that could make these kinds of technical advances possible, especially since this long-term R&D horizon is beyond the scope of most companies' R&D programs.

Subcommittee on Overcoming Near-Term Implementation Barriers to the Transportation Infrastructure

Dr. Lloyd introduced Dr. McCormick to present this Subcommittee's report. Dr. McCormick noted that many of the issues relating to infrastructure barriers were discussed at length yesterday, and so he would not repeat that discussion today. He mentioned that liability is a difficult issue, but one that really needs to be solved. He also pointed out that some of the code and permitting issues associated with on-site storage and compression are a particular problem in the U.S.

Because of Congress' particular concerns about Hawaii's energy dependence on oil (EPACT Section 355), Mr. Walker asked if the group discussed whether Hawaii should be added to New York and Los Angeles as a choice for near-term hydrogen infrastructure development. Dr. McCormick replied that the group did not form a consensus opinion on the subject. He said, however, that there was generally not a lot of support for this, since the preference is for infrastructure that can expand out incrementally, and that Hawaii, as a series of small islands, represents a limited opportunity to do this. Mr. Walker noted that while this might be true, Hawaii offers some unique opportunities and could help to generate political support for demonstration projects there. Dr. Milliken and Dr. Gronich responded that DOE has conducted a study on using wind, geothermal, and biomass energy on the Big Island to generate hydrogen, and offered to share this report with the HTAC.

Continuing on with the report from the Subcommittee, Dr. McCormick stated that the group recommended adding some outside experts to this Subcommittee and empowering them to convene and report back to the HTAC within a year. He suggested that these individuals (representing energy, industrial gas and auto companies, and Fire Marshals) be chosen for their ability to contribute to the question of how the barriers described can be addressed, in order to develop an "action plan" for the HTAC. Mr. Walker suggested that this group include a representative of the state legislatures, for example from the Council of State Legislators, to which Dr. McCormick agreed.

Dr. McCormick reported the Subcommittee's recommendation that funding be restored for the Safety, Codes and Standards and Education program areas, since these are essential for overcoming the implementation barriers. Picking up again on the liability issue, Mr. Keuter reported that this is a major barrier in the near term. The ensuing discussion identified several instances where government has acted to limit liability for new technology or technology deemed to be in the national interest, such as the Price-Anderson Act, the Overseas Private Investment Corporation (OPIC), and the Federal Aviation Administration's indemnification of aerospace activities.

Mr. Mudd commented on the apparent contradiction between statements by some Committee members that the technology is safe and that codes and standards should be expedited, and the expressed need for government-backed insurance to limit the industry's exposure to liability. He noted that, thus far, similar efforts to secure government indemnification for injection of carbon dioxide in carbon sequestration have been unsuccessful (even though this technology has never been used before).

Mr. Katsaros replied that if the industry could get normal insurance coverage for hydrogen and fuel cell technologies, it would go and buy it. The problem is that the insurance companies do not offer it because

the technology is too new and the track record is not there. He noted that the FutureGen project has a similar problem—since there is no history, the insurance companies cannot write the policies. Mr. Bawden responded this should be thought of as *transitional* coverage, which would only be in place long enough for the industry to adequately demonstrate its safety and secure conventional commercial insurance coverage. Dr. Lloyd asked the group if it should create an action item for dealing with the liability issue. The group agreed that this subject should be brought to the attention of the Interagency Task Force, and that the Task Force should respond on whether this is a subject on which the government is willing to take action. Mr. Vesey suggested that there might be value in bringing an insurance agency representative into the Committee’s discussion on this. There was general agreement from the Committee that this would be useful. Ms. Kathi Epping took an action to coordinate with Mr. Mudd on bringing in an insurance representative who has contributed to liability discussions on carbon sequestration.

Subcommittee on Overcoming Near-Term Implementation Barriers to Power/Portable Power

Mr. Bawden reported that this Subcommittee focused mainly on the scope of the group, and developed the following four focus areas:

- Understand the current and future codes and standards process.
- Identify a generic set of requirements for portable and stationary applications, which, if met, will qualify a technology or a product including hydrogen fuel systems/fuel cells for transport aboard passenger and cargo aircraft.
- Create a Federal Hydrogen Regulatory Commission, with national priority and authority to overrule local jurisdiction, in order to shorten the time to market for hydrogen and fuel cell products.
- Evaluate promoting a fast-track regulatory process for emerging energy technologies.

When asked about the chances of achieving a “Federal Hydrogen Regulatory Commission,” Mr. Walker replied that a federal-level regulatory commission that would pre-empt local and state jurisdictions would be a problem constitutionally. Mr. Reinsch asked whether limiting the proposed Federal Hydrogen Regulatory Commission to *interstate* hydrogen commerce issues would solve that problem, while also creating a forum for some standardization. Mr. Walker asserted that this level of Federal oversight would still not solve the problem of a township that determines not to site a hydrogen station anywhere within its borders—this would still require a process that works the problem through the states. He notes, for example, that even with the imperative of protecting national security, the Department of Homeland Security still has no authority to require the states to use any particular communication systems.

Mr. Walker also cautioned that when you create federal regulatory bodies, they can be helpful in terms of creating a set of national standards, but they can also be an impediment to moving forward quickly because they are not going to regulate without a thorough understanding of what the end product needs to be. He added that since there are a lot of unknowns in this particular area, this could end up delaying the effort to establish regulations even further.

Mr. Bawden continued to stress the need for more consistency in codes and regulations and for a higher priority so that the needed codes and regulations are developed sooner. Mr. Chernoby noted that there is general agreement that “patchwork regulations” in the U.S. is a major barrier to implementation and asked if the Interagency Task Force could be asked to address this issue in the national hydrogen action plan. Mr. Walker suggested that the HTAC could deal with this by developing a single resolution recommending that the Task Force create the action plan and specify the particular topic areas (e.g., liability, regulations and codes) that the Committee hopes they would address as part of the action plan.

Mr. Bawden remarked that it might be interesting to do an analysis of what would happen in the absence of any changes in the regulatory and code setting processes. That is, if we cannot speed up the process of

moving these technologies to market, where will we be in 30 years on energy? Dr. Shaw concurred, adding that time is not on our side and that inroads on reducing greenhouse gases are needed quickly. Dr. Lloyd inquired if this is something that DOE or one of the national laboratories could take on. Dr. Milliken responded that DOE would look into this and present something at the next meeting. Mr. Bawden offered to work with the DOE team on this.

Subcommittee on Science and Engineering Needs

Dr. Taylor presented this Subcommittee's report. She commented that the Posture Plan does a good job of describing the broad elements of basic research work supported by DOE for the benefit of the hydrogen economy. She noted that for her presentation (provided, like the others, in the public proceedings of the HTAC meeting) she grouped the technical hurdles to be overcome into three general categories: 1) issues related to the Hydrogen Technology Advisory Committee and the Hydrogen Program; 2) Technology; and 3) Research Funding. She added that her summary presentation has not yet been reviewed and approved by the group, so it may need further refinement. Her summary of the group's input follows:

- *Issues Related to HTAC and the Hydrogen Program:*
 - Need to develop a vision of where we are going in a broad sense, and the role of hydrogen is one element of that vision.
 - Need to prioritize. By doing so, the conclusion may be that it is not right to zero out funding of some areas. The Subcommittee is not completely comfortable with how funding priorities are currently established. She noted that there was also some concern expressed for over-promising what it is possible to do, and for setting targets that might be too aggressive.
 - Need to establish a process for cycling back to basic research if a pathway is dropped because it is not projected to be cost competitive and a breakthrough is needed to make it so. Dr. Taylor also warned against selecting a technology early on as the approach to take if it is known that it is not going to achieve the end-goal, since our focus today will strongly influence our capabilities in later years.
 - Dr. Taylor shared the group's concern that addressing basic research by a standing Subcommittee on Science and Engineering Needs is not optimal. Rather, the HTAC as a whole may benefit more by dispersing the members with basic science expertise among the other Subcommittees, so that they can provide input in areas where basic science can contribute to that particular area. Or, she suggested that task forces could be set up to address a specific topic area and then report back to the HTAC and disband.
 - With regard to the annual Hydrogen Program Review, Dr. Taylor stated that it is very important to communicate the technical status and needs to the basic science community so that they know where to focus their research efforts.
- *Technology:*
 - Need to provide better communication on what is blocking achievement of a goal, and what breakthroughs are needed.
 - Seek revolutionary breakthroughs in technology to eliminate barriers. Dr. Taylor noted that an area in broad need of basic research is new materials. She commented that the U.S. is not competitive worldwide in the materials area.
- *Research Funding:*
 - Innovative new ideas often come from individual investigators, whereas advances on the applied research side often benefit from a more interdisciplinary approach, where groups of researchers with a variety of expertise come together to work a problem. Dr. Taylor noted that the problem is that grants for individual investigators are often too small to support a long-term effort. She commented that the return rate on grant proposals (i.e., number of grant proposals written vs. number of awards received) is dismal, at about 10%.

- Request-for-Proposal process used by DOE is a very effective way to communicate and stimulate work in the areas of need, but it needs to follow through with funding.

Dr. Milliken stated that the Subcommittee's points are all excellent. She wanted to add that with regard to getting the message out to the basic research community, the staffs in the Office of Science and in the applied research programs participate quite often in meetings of the technical societies, such as the American Chemical Society, the American Physical Society, and the Materials Research Society to communicate to faculty and students. Dr. Richmond replied that although the message may spread, if there is no funding to support the researchers, then who is going to care? If researchers know that the chance of a proposal being funded is 10% (or 20% in a good year), then what is the point? Dr. Richmond declared that what was so exciting about the Solar Energy Initiative was the tremendous amount of enthusiasm that it generated nationwide from scientists; but that with the Continuing Resolution, the promise for increased research in this area appears to be gone. Dr. Milliken asked if there were any other suggestions for how DOE could better communicate with the basic research community. In response to a question about whether the National Science Foundation is a member of the Interagency Task Force, Dr. Milliken replied that yes, it is.

Mr. Chernoby stated that many of the Subcommittee's needs relate to a lack of funding. He suggested that perhaps one of the best things this Committee can do in this regard is to urge Congress and the Senate to provide the Secretary the latitude he needs to deal with that appropriately, without the burden of having to fund earmarks.

Dr. Milliken stated that the program is searching for ways to introduce more innovation. She explained that they are working with Congress to develop an "H-Prize" to offer more incentives to the research community. Dr. Richmond asked if this prize would be for one person, and Dr. Milliken responded that it is designed for an individual or a group of individuals. Mr. Reinsch replied that while this may be good for that individual and as a way of adding "jazz" to the program, the discussion concerns a more basic level, which is "bread and butter" for the wider research community. Dr. Shaw stated that he is not especially troubled by the numbers of 20% or even 10% funding of research proposals. He expressed his perspective from the way the things work in the business world: when people graduate from, for example, MIT, and enter the private sector, they apply to get funding for their business. He suggested that one in a hundred, at best, of those actually get money from the private equity world, and only one in ten of those actually experience serious success. To this, Dr. Richmond suggested that almost all of these people are trained by getting research grants in universities. Dr. Shaw responded, that what he is troubled by is the fact that there are a lot of things that don't get funded—priorities get made. Are the really good ones, for reasons of technical merit, getting picked for funding?

Mr. Walker responded that the Committee cannot put the DOE staff in the position of looking for more funding; he knows from personal experience that the DOE must support the President's Budget. However, he noted that perhaps the Committee can look for other ways of providing support for basic research, and that he would appreciate any comments on how to do this in the public comment period. He questioned whether any funding from foundations could be used for this purpose, and suggested that this could be an area of investigation.

In response to a question from Dr. McCormick about the recommendations of the "Augustine report" [National Academy of Sciences, *Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*], Mr. Walker commented that most of the report's recommendations were focused on the need for more science education in kindergarten through 12th grade. The Augustine report was also concerned by the fact that the U.S. is unable to attract foreign students, due to a variety of national policies that has undermined the students' ability to study in the U.S. Mr. Walker noted that he did not recall any recommendations related to the peer-review issue in the Augustine report. Dr.

Dresselhaus noted that the "Gathering Storm" report, which strongly supported education, also strongly emphasized that the U.S. is losing its competitive edge in the worldwide scientific community, which will affect our industry upstream.

Dr. Dresselhaus reiterated that the U.S. weakness in materials research is a big deficit to the nation. Mr. Walker agreed that the national priority in the sciences has been on health sciences, which received a doubling of their budget over a period of five years. He added that there now appears to be a push within Congress for the physical sciences to get a similar kind of increase. Dr. Taylor said she applauds the DOE for the Hydrogen Prize and thinks that this creates something that is a little different out there for stimulating interest.

Dr. McCormick stated that industry can't do high-risk research due to lack of funding. Mr. Katsaros added that industry is going through a huge change. He noted that some of the great research labs have failed, that Bell Labs operates in name only, and that most corporate research is now focused exclusively on developing products and applications. He stated that if this country is going to succeed, it must have fundamental research conducted somewhere, and that the university system and national labs are the only places left where this kind of work is done. He stressed the need for increased funding levels for basic research at these institutions.

Mr. Vesey suggested that given the high level of agreement on this topic, the HTAC should support some of these Subcommittee's recommendations as a full Committee. He added that he disagreed, however, with the Subcommittee's warning against investing in RD&D in technologies that will not provide a long-term answer. He added that natural gas reforming, while not a long-term supply solution, does help to provide affordable hydrogen over the transition.

Dr. Lloyd asked whether the Subcommittee had specific recommendations for Task Forces that could be useful. Dr. Taylor responded that a task force on safety, codes and standards could help to identify the areas where basic science can contribute. She also suggested that a task force on materials needs might be appropriate.

Dr. Ramage asked whether the Committee has an understanding of how the approximately \$500 million budget for DOE's Office of Basic Energy Sciences (BES) budget is spent? That is, do we understand how this supports or overlaps with the \$35 million that BES spends specifically for hydrogen-related research? Dr. Ramage commented that a request for increased funding could be problematic, since every committee like this recommends increased funding. He stated his view that there is already a great deal of money provided for basic research in DOE. He added that basic research funding has recently been shifted towards renewable energy and physical sciences, and that the Administration could argue that it has already responded. Dr. Dresselhaus stated that the President's 2007 Budget, when it went to Congress, was a very favorable budget and would have had a big impact on the basic science program, due to the American Competitiveness Initiative. She suggested that the HTAC could make a statement that this initiative is very important for hydrogen and that the Committee would like to see every effort made to maintain the planned funding so that the program can move forward as quickly as possible. Dr. Ramage explained that such a recommendation would be appropriate—that he thought the intent was to make a much broader recommendation on funding for basic research in hydrogen.

Mr. Walker summarized the action for the HTAC. He explained that the Committee itself cannot write a letter directly to Congress, but that they would resolve to prepare a letter to the Secretary communicating the Committee's view: that the HTAC was encouraged by the programs and funding directed towards basic research in renewable energy and physical sciences in the President's 2007 budget, and that the Committee recommends this funding be sustained in 2007. The Committee agreed and it was noted that this action should be accomplished very soon, within the next month.

Mr. Wooten commented that he would like to see the Committee add to this, as discussed previously, a recommendation that we identify hydrogen production pathways that do not appear to be technically or economically viable without major scientific breakthroughs and cycle these back into the basic research area. He questioned whether all of the pathways are receiving the right amount of basic research support, and whether the basic research funding is correctly distributed among the top priorities.

Dr. Dresselhaus noted that prior to the Hydrogen Fuel Initiative, and the direction of basic research funding towards hydrogen-related work, there were very few papers on this topic at the technical conferences. She reported that the 2003 APS conference had zero papers on hydrogen out of 6,000 papers, whereas this year's APS conference has parallel sessions on hydrogen-related topics. She shared her assessment that the first solicitation on hydrogen offered by the Basic Energy Sciences Program has been very productive because people are now emerging into a new area, bringing ideas that they have developed from other fields. She said that cutting these new research opportunities off at this time would be very unproductive. She concluded that this is the kind of message that she would like the Committee to deliver to the Secretary.

Dr. Milliken expressed her concern that an underlying assumption in these discussions is that breakthroughs only come from basic research. She emphasized that the applied research programs at DOE also include a certain amount of what falls into exploratory, high-risk research. She pointed to EERE's R&D programs in hydrogen storage and photoelectrochemical and biological hydrogen production as examples. Mr. Wooten responded that perhaps "basic" research is the wrong word to use. He noted that as long as it is exploratory research, aiming to develop innovative concepts and breakthrough solutions to technical challenges, then he does not care what terminology is used.

Dr. Milliken stressed that the Committee needs to recognize that DOE makes a clear distinction, organizationally, between their "basic science" and "applied research" programs. She asked the Committee to keep this distinction in mind when crafting its recommendations, and pointed out that high-risk research should be supported in the both the applied R&D and basic research programs. Mr. Walker noted that the funding for these areas within DOE is overseen by two different Congressional Committees, so this message should be delivered to both Committees.

III. National Academy of Sciences (NAS) Upcoming Studies

Dr. Ramage briefly described two studies being undertaken by the National Academy of Sciences, National Research Council for the DOE. Asked about the audience for the two reports, Dr. Ramage replied that the primary audience is Congress, since these studies are being undertaken in response to requests from Congress. He noted that the studies will typically make specific recommendations, and will offer opportunities to testify before Congress on the findings.

NAS Study #1: Assessment of Resource Needs for Development of Fuel Cell and Hydrogen Technology

Dr. Ramage explained that this NAS study is being conducted in response to EPAct and as a follow-up of the 2004 NAS Report on the Hydrogen Economy and a report by the Fuel Cell Council. Dr. Ramage stated he is chairing the committee; the other study team members include Dr. Shaw, Dr. Friedman, and 13 other people. The first meeting of the study committee is in February 2007. The overall goal of the committee is to "carry out a study of fuel cell technologies that provides a budget roadmap (e.g., what investments in R&D, demonstrations, skilled people, infrastructure will be required) for the development

of fuel cell technologies and the transition from petroleum to hydrogen in a significant percentage of vehicles by 2020.” Dr. Ramage went on to highlight some of the key issues that the study will address:

- Establish as a goal the maximum practicable percentage of vehicles that can be fueled by hydrogen by 2020.
- Determine the amount of funding required to meet this goal, both public and private.
- Determine what actions are required to meet this goal.
- Examine the need for expanded federal R&D programs, changes in regulations, grant programs, partnerships with industry, private sector investments, infrastructure investments, education and outreach, tax incentives, etc. to meet the goal.
- Consider how hydrogen use in stationary electric power applications, portable power, and advanced vehicles could help to stimulate the transition to hydrogen fuel cell vehicles. Also, consider whether other vehicle technologies could be more quickly implemented than fuel cell vehicles to significantly reduce greenhouse gas emissions and oil imports. He indicated that the committee would likely look at diesel hybrids here.
- Consider challenges, difficulties, and potential barriers, and then develop a budget roadmap, with annual spending required from both the private and public sector.

Asked about the schedule for the report, Dr. Ramage explained that five meetings of the study committee are scheduled, and that they hope to have a draft of the report by August and a final report by the end of 2007.

NAS Study #2: Review of the FreedomCAR and Fuel Research Program, Phase 2

Dr. Ramage stated that this Committee has been established to conduct an independent review of the R&D program of the FreedomCAR and Fuel Partnership, which includes hybrid-electric vehicles, advanced batteries, and advanced combustion vehicles, as well as hydrogen and fuel cell vehicles. He noted that he and Dr. Taylor are both members of the study committee. This study is undertaken every two years, at the direction of Congress. (He later added that this is a separate effort from the NAS review of the DOE Hydrogen R&D Program, which occurs every four years.) Dr. Ramage indicated this is a smaller effort than the first study, and will require fewer meetings. In the interest of time, he referred the Committee to the statement of work for the study, which is provided in the proceedings of the public meeting.

IV. Public Comment Period

Dr. Lloyd noted that two people had pre-registered to provide public comments, and that he would take their comments first: Mr. Robert Rose, U.S. Fuel Cell Council (USFCC), and Mr. Jerome Hinkle, National Hydrogen Association (NHA). Dr. Lloyd introduced Mr. Rose.

Mr. Robert Rose, Executive Director, U.S. Fuel Cell Council

Mr. Rose thanked the Chairman and stated that he had a couple of very brief comments. He asked the group to pardon him if his comments seemed presumptuous. He inquired whether the presentations made today by the HTAC Subcommittees could be made public on the HTAC website, and suggested that the HTAC invite comments from the public on these in order to broaden the feedback loop. He added that there are a lot of interesting ideas in the papers, and that one of the congressional charges to the HTAC was to interact with the industry. He remarked that he thinks the Committee would likely receive some comments that would enrich the debate. Dr. Lloyd replied that he did not see any reason the Committee could not do this; Dr. Milliken concurred, and said that DOE would post the presentations to the website. Mr. Rose suggested that the comment process did not need to be formal or published, and that if the comments received were made available to the Committee members that this would suffice. Dr. Lloyd

thanked Mr. Rose for his offer to provide comments and noted that input from the USFCC and NHA members and staff would be appreciated.

Mr. Rose offered his observation that the issues of liability, codes and standards development, implementation of codes and standards, and education are all aspects of the same issue. For example, he noted that the more educated the insurers are, the easier it is for them to write policies. Mr. Rose went on to compliment the Department of Energy and their staff for a well-coordinated meeting, and noted the difficulties in putting together a meeting like this, especially at the beginning of the year. He also offered his appreciation to the Committee members for their contributions and for serving in this important role. As a final comment, he expressed his gratitude to Mr. David Garman, stating that he wanted to publicly thank Mr. Garman for his service to the hydrogen fuel cell community. He noted that the impact of Mr. Garman's leadership is difficult to measure, and that he will probably not get as much credit as he deserves. Dr. Lloyd thanked Mr. Rose for his comments and noted that the Committee agrees with him on the excellent contributions made by Mr. Garman, and plans to write a letter to the Secretary of Energy recognizing his efforts.

Dr. Lloyd then introduced Mr. Jerry Hinkle as the next speaker.

Mr. Jerome Hinkle, Vice President, Policy and Government Affairs, National Hydrogen Association

Mr. Hinkle reported that prior to joining the National Hydrogen Association he spent several years working on the National Energy Bill (EPAAct 2005). He noted that two important pieces of this legislation are Title VIII on Hydrogen and Title VII covering federal procurement. Mr. Hinkle referred to a handout on the NHA's Annual Hydrogen Conference in San Antonio in March 2007. He noted he is putting together two sessions for the conference: one that deals with policies and incentives for hydrogen, and the other deals with hydrogen and climate change. He stated he welcomes people who would like to speak or who have some ideas with respect to those sessions.

Mr. Hinkle provided a handout to the Committee members on EPAAct 2005, and made some brief comments. He noted that Section 1825 of EPAAct, which calls for the NAS resource assessment study, should shed some light on the funding needs for hydrogen. He described the purposes of Section 802 of EPAAct: enable and promote comprehensive development, demonstration, and commercialization with industry; make critical public investments; build a mature hydrogen economy; sharply decrease U.S. dependence on foreign oil; and create, strengthen and protect a sustainable energy economy. He called attention to Title VII provisions for federal and state procurement of fuel cell vehicles, hydrogen energy systems (Subtitle F, Section 782) and stationary, portable, and micro fuel cells (Subtitle F, Section 783). He then referred to a chart that showed different visions for hydrogen spending. He noted that the line showing DOE spending (both appropriated and projected) in support of the President's Hydrogen Fuel Initiative (\$1.2 billion from FY 2004 -2008) was well below the level of funding authorized in EPAAct for 2007-2010. He noted that the DOE funding covers only the R&D program; EPAAct goes beyond R&D to support activities needed to move to commercialization. He added that there is language in the Bill authorizing some funding out to 2020. He concluded that the amount which the Government has signaled that it is willing to commit to this is in the neighborhood of \$13 billion. Mr. Hinkle expressed his appreciation to the Committee members and stated his hope that the Committee will take the opportunity to offer some strong recommendations to the Secretary. This concluded Mr. Hinkle's remarks.

Other Public Comments

Dr. Lloyd asked for other comments from the public, and recognized Mr. Jesse Schneider, DaimlerChrysler Corporation. Mr. Schneider stated that he is the industry Co-Chair of the Codes and Standards Technical Team (CSTT) (within the FreedomCAR and Fuel Partnership), and noted that the

subject of codes and standards came up quite often in the Committee's discussions. He stated that the CSTT is providing input on projects that will generate data to meet the near-term needs of fleets and stationary power applications, and that they are working towards a 2010 milestone on this. He offered to present more detail on this as part of a briefing to HTAC on codes and standards activities. He referred the Committee to the CSTT Roadmap, and noted that milestones are presented. He stressed that it is important to align the industry's milestones and expectations for codes and standards development with the milestones presented in the CSTT Roadmap. He added that there are a variety of different forums working the codes and standards issues, and specifically mentioned the Society of Automotive Engineers' Fuel Cell Committee and the Transportation Working Group at the U.S. Fuel Cell Council.

Mr. Schneider pointed out that there is a separate Hydrogen Safety Panel that provides oversight on project safety issues and actively reviews the safety of R&D projects in the field (as funding allows). He added that funding for this activity has been reduced as a result of appropriation shortfalls. He also pointed to a lack of funding for exploring some other key issues, such as high-pressure storage and fueling, which needs to be better understood. He noted that there is a study underway to evaluate 700-bar (10,000 psi) refueling, which is receiving some funding from DOE, energy companies, and automotive companies, but that additional funding is needed.

Mr. Schneider described an ongoing effort to better understand the effects of hydrogen quality on fuel cell operation. He stated that a Hydrogen Quality Working Group has been established to investigate this; and that industry is co-funding a study on effects of hydrogen quality at the University of Hawaii, using fuel cell equipment provided by Ballard, UTC, and GM.

Mr. Schneider added that he agreed that getting the states involved with the codes and standards efforts is necessary to accelerate the permitting process. He noted that without state laws providing guidelines, every local jurisdiction is free to set whatever standards and permitting requirements they want. He pointed out that Michigan has developed some uniform codes, but that no such thing exists in California, New York, or Florida. He shared his opinion that one of the biggest issues right now is the bottleneck of building stations, not because the providers aren't there, but because the stations can take two or three years to obtain a permit. He added that one way to affect this is through education efforts. Mr. Schneider concluded by reiterating his desire to present more information on this subject to the HTAC, and noted that Mr. Pat Davis (DOE Co-Chair of the CSTT) would also make valuable contributions to this discussion. He suggested that the briefing on codes and standards to the HTAC also leverage the resources and ongoing activities of the U.S. Fuel Cell Council's Transportation Working Group and the California Air Resources Board (CARB).

Dr. Lloyd asked for other public comments; hearing none, he ended the public comment session at 10:56 a.m.

V. Action Items and Agenda for Next HTAC Meeting

Dr. Lloyd resumed the meeting following the lunch recess and asked for comments from the Members on action items or agenda items for the next HTAC meetings.

Mr. Bawden stated that he would like to see a list of all the ongoing codes and standards activities across DOE, USFCC, DOT, industry, the National Association of State Fire Marshals/Hydrogen Executive Leadership Panel (NASFM/HELP), etc. He would like the input presented as a matrix showing the agency/organization, scope of activity, and timing of deliverables. He recommended that the analysis include "anything that touches on the hydrogen economy," and cover all applications: stationary, portable, and transportation fuel cells, infrastructure, etc. Mr. Bresland and Mr. van Dokkum suggested

that the briefing for the HTAC on codes and standards include a presentation from the NASFM/HELP. Dr. Lloyd confirmed the action to develop this accounting of codes and standards activities, and provide it to the HTAC before the next meeting. He also confirmed the action to provide a presentation to the HTAC on codes and standards activities.

Dr. Shaw asked about the schedule for producing the Committee's report, and suggested that they need to get started on this soon, to which Dr. Milliken agreed. Dr. Shaw suggested that the Committee devote at least a half a day at the next meeting to begin working on recommendations and inputs for the report.

Dr. Lloyd suggested that the group hold a conference call between now and the next face-to-face meeting in May. He suggested that one thing that needs action fast, and which could be addressed in the conference call, is finalizing the letter to the Interagency Task Force that lists the inputs the Committee is asking from them in time for the October report.

Mr. Chernoby stated that he would like to get a briefing from DOE on what has been done in the area of Education and how effective this has been. Dr. Milliken replied that DOE could show the videos that have been developed, play the radio spots, and go through the on-line training that has been developed for first responders. She said that this could be done off-line, perhaps as a dinner activity, if this requires too much agenda time.

Asked about the timeframe for the next HTAC meeting, Ms. Epping stated they might be able to schedule up to three days, since the HTAC members will be attending the morning plenary session of the Hydrogen Program Review on Tuesday, May 15, 2007. She noted that the HTAC meeting was currently scheduled to start on Wednesday, May 16, concluding some time on the 17th, depending on how much time the Committee determines they need. Dr. Shaw recalled that the proposed adjournment time for May 17 was 3:00 p.m. Ms. Epping stated that the May HTAC meeting would be held at the Crystal City Marriott, which is across the street from the Crystal Gateway Marriott, where the Hydrogen Program Review is being held.

Dr. Shaw asked if the group could address the issue raised previously by Dr. McCormick: arranging a non-public session for discussions on the technical status of today's technologies and systems. He contended that getting feedback from the industry on this was very important to ensuring that the goals called for in the Posture Plan are all truly stretch goals. Dr. McCormick characterized the issue in another way. He explained that there are definitely limits to the current technology, but that innovative system design and engineering can help to overcome these constraints on a systems-level. For example, larger compressed hydrogen storage tanks to accommodate a 300-mile range may require design innovations for where to locate the tank, how to balance the weight, how to re-distribute the total costs, etc. So, he explained, the targets themselves are not the whole story—it is also the “technical accommodations” that can be made to make up for the technical limitations.

Continuing the discussion of possible venues for a technical status meeting, Dr. McCormick replied that he could potentially host a tour for HTAC members at GM's Rochester, New York research facility and have a working dinner to include technical staff who could provide more detail on critical milestones. Dr. Ramage noted that what is most important is where industry is along the critical path. He added that while visiting the research facilities and seeing the technologies would be nice, that it is the status towards targets that is important for the Committee to know. He asked whether the Committee has access to information on DOE's understanding of the technical status. Dr. Milliken replied that the DOE targets and technical status are all included in their multi-year plan, and that DOE would take an action to pull the target tables out of the plan and provide them to the Committee for easy reference.

Dr. Shaw asked DOE whether it would be possible to hold a discussion on technical status under a non-disclosure agreement (NDA), such that everyone present in the room has signed an NDA and is legally-bound not to disclose any of the information that is discussed. Dr. McCormick added that these are commonly used among the automobile companies in their technical discussions. Mr. van Dokkum agreed that with an NDA in place he would be willing to bring some engineering staff to a meeting to present on where we really are in terms of durability and costs. Dr. Shaw offered to try to bring in some of the entrepreneurial community to the discussions. Other industry members also agreed that they could bring technical staff to such a discussion. Ms. Epping took an action to work with DOE General Counsel to determine if it is possible to hold a closed meeting with NDAs in place. It was noted that any HTAC members who do not feel comfortable with signing an NDA could recuse themselves from the meeting. Ms. Epping is also going to check on whether this could be an industry-only meeting, or whether a government representative (the "Designated Federal Officer" for the HTAC) must be present. It was proposed that this meeting be held on the afternoon of Tuesday, May 14, before the next public HTAC meeting begins.

Moving on to another topic, Mr. Mudd suggested that a strawman Table of Contents for the HTAC report be prepared and discussed at the next HTAC conference call. This was agreed to by the Committee members and taken as an action by HTAC support staff. Mr. Mudd suggested that the Table of Contents be drafted at the chapter-level, and that assignments could be made during the conference call for writing the sections.

Dr. Milliken reminded the Committee members of Assistant Secretary Karsner's pledge to fast-track the HTAC's recommendations to his desk and Secretary Bodman's desk. She encouraged the Committee to take advantage of that, and to get any recommendations that they feel strongly about out as soon as possible, rather than waiting for the final report in October. Dr. Dresselhaus asked if someone could develop a list of all the recommendations that have been proposed for consideration. This was agreed to by the Committee and taken as an action by DOE. It was noted that the Committee needs to act especially fast on some of its recommendations, including any that hope to impact the outcome of the Continuing Resolution on the 2007 federal budget.

Dr. Lloyd suggested that a detailed list of action items also be produced for the Committee and distributed fairly quickly. A draft agenda for the HTAC conference call, which will be scheduled between now and the May meeting, will then be developed and circulated.

The meeting was adjourned at 12:17 p.m., January 10, 2007.