

HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE

MEETING MINUTES -- DRAFT

July 31 - August 1, 2007
Crystal City Marriott, Arlington, VA

Agenda in Brief/Table of Contents

JULY 31, 2007

1. <i>Opening Remarks from Chairman Lloyd</i>	1
2. <i>Update on FY 2008 Hydrogen Program Budget Marks</i>	2
3. <i>Discussion of the Hydrogen and Fuel Cell Interagency Task Force</i>	4
4. <i>Briefing on DOE Well-to-Wheels Analysis</i>	7
5. <i>DOE Progress Report on Fuel Cell Learning Demonstration</i>	11
6. <i>HTAC Members' Preparation of the Posture Plan Review Report to the Secretary (Part 1)</i>	12
7. <i>Briefing on International Analysis Projects</i>	13
8. <i>HTAC Members' Preparation of the Posture Plan Review Report to the Secretary (Part 2)</i>	14
9. <i>Overview on Hydrogen Prizes</i>	17
10. <i>Update on the Hydrogen Executive Leadership Panel (HELP)</i>	18
11. <i>Status of Codes & Standards for Hydrogen Fueling Stations and Hydrogen Facilities</i>	19
12. <i>Closing comments for the day from the Committee</i>	20

AUGUST 1, 2007

13. <i>Remarks from Deputy Assistant Secretary for Renewable Energy Steve Chalk</i>	21
14. <i>Final Steps for the First HTAC Report to Secretary Bodman</i>	21
15. <i>National Petroleum Council Report Summary</i>	23
16. <i>Public Comment Period</i>	26
17. <i>Statements from Assistant Secretary Karsner</i>	26
18. <i>Wrap up, Other Business, and Next Steps</i>	28

JULY 31, 2007

The meeting of the Hydrogen and Fuel Cell Technical Advisory Committee (HTAC or Committee) was called to order at 9:00 a.m. EDT by Dr. Alan Lloyd, HTAC Chairman. Fifteen HTAC members were present and eight members were absent (list attached).

1. Opening Remarks from Chairman Lloyd

Chairman Lloyd welcomed the group and congratulated Dr. JoAnn Milliken for her promotion to the position of Program Manager for the Department of Energy's Hydrogen Program. Dr. Milliken announced that Secretary Bodman recently invited three people to join the HTAC as

new members: Robert Rose (U.S. Fuel Cell Council), Gerhard Schmidt (Ford Motor Company), and a third unnamed member from whom they are awaiting a response. The new members replace three who are leaving HTAC: Craig Venter (J. Craig Venter Institute), Uma Chowdhry (DuPont) and Jim Reinsch (Bechtel Power). Chairman Lloyd stressed that the Committee was not involved with the selections, but he expressed his pleasure with the depth and breadth of the experience that the new members will bring. Mr. Rose thanked the Committee for their reception and said that he looked forward to working with the HTAC and contributing in whatever way he can. He regretted that he would be unable to attend most of the July 31-August 1 HTAC meeting, since he was only notified of his appointment on July 27 and was unable to rearrange his schedule.

Chairman Lloyd reviewed the HTAC meeting agenda for July 31-August 1 (the agenda is posted at http://www.hydrogen.energy.gov/htac_meeting_july07.html). Vice Chairman Walker stressed the importance of completing work on the letter report to the Secretary. Dr. Shaw asked about whether the annotated Posture Plan was on the agenda, noting that it might be difficult to finalize both the letter report and the annotated Posture Plan during the meeting. Dr. Milliken stated that the detailed comments on the Posture Plan are of lower priority than the letter report, noting that the letter report is a time-sensitive deliverable to the Secretary in advance of his first report to Congress on the HTAC's recommendations. The HTAC's annotated comments on the Posture Plan are not as time-critical; they will be provided to the Hydrogen Program staff to address in the next version of the Posture Plan. Dr. Milliken suggested that if the agenda does not provide enough time for the HTAC to complete its work on the annotated Posture Plan, a follow-up conference call could be scheduled. Dr. Millie Dresselhaus noted that the Posture Plan breakout groups provided fairly thorough comments, but it was not clear to her whether all the comments were captured in the annotated plan. She suggested continuing with the group method to get convergence. Dr. Lloyd agreed that the work done by the groups should not be lost. Ms. Kathi Epping pointed out that HTAC support staff attempted to include the breakout groups' comments in the annotated Posture Plan that was sent to the HTAC for review prior to the July 31 meeting. She asked the HTAC members to let DOE know if any of the comments had been missed. She further suggested that the HTAC members could have discussions over email to capture additional comments and ideas.

Chairman Lloyd asked Dr. Milliken to address an *Energy Washington* news article, which reported on the results of an interim report issued by the National Renewable Energy Laboratory (NREL) on the first two years of the learning demonstration project. The news article claimed that according to this NREL report, fuel cells are not meeting DOE targets. Dr. Milliken explained that the *Energy Washington* reporter contacted the NREL manager of the learning demonstration project, but did not wait for the source to respond with data and clarifying information before publishing the article, which puts a negative spin on the project. The DOE has prepared a one page brief that describes the highlights of the interim report from the learning demonstration project, and shows that the project is on track and has made good progress—more on these results are presented in Section V of the minutes. (This brief, “DOE Publishes Progress Report on Fuel Cell Learning Demonstration,” is posted at <http://www1.eere.energy.gov/hydrogenandfuelcells/>).

2. Update on FY 2008 Hydrogen Program Budget Marks

Dr. Milliken presented on the hydrogen program budget marks from the House and Senate committees. Her presentation is available online at http://www.hydrogen.energy.gov/pdfs/htacjuly07_budget.pdf. Dr. Milliken explained that in 2003 the President committed \$1.2 billion to the Hydrogen Fuel Initiative for the five-year period FY04-08. She noted that the President's request for Hydrogen Fuel Initiative funding in FY04-08 has been \$1.267 billion. She showed the Congressional appropriations from FY04 through FY07

and the 2008 President's budget request, and noted that this totals \$1.194 billion, very close to the \$1.2 billion. She presented the budget breakdown for the organizations that participate in the Hydrogen Fuel Initiative--four DOE offices (Energy Efficiency and Renewable Energy, Fossil Energy, Nuclear Energy, and Science) and the Department of Transportation. Dr. Milliken noted that the Office of Energy Efficiency and Renewable Energy (EERE) program has the largest share of the budget and the widest scope, which includes hydrogen production, storage, PEM fuel cells, codes and standards, and a variety of cross-cutting activities. The Fossil Energy component of the Hydrogen Fuel Initiative includes R&D for hydrogen production from coal—it does not include the Office's R&D on high-temperature stationary fuel cells or carbon sequestration, which are separate budget items. Likewise, the Nuclear Energy component of the Hydrogen Fuel Initiative budget includes only the funding for hydrogen production from nuclear energy. On another slide, Dr. Milliken presented the budget breakdown for EERE, to show how the Hydrogen, Fuel Cells & Infrastructure Technologies Program (HFCIT) compares with other programs within the Office of Energy Efficiency and Renewable Energy. The FY08 request for HFCIT (\$213 million) places the program at the top relative to other EERE programs. Dr. Milliken noted that the House budget mark for HFCIT in FY08 was \$213 billion, while the Senate mark includes an additional \$15 million in the Technology Validation program budget for a total of \$228 million.

Mr. Wooten asked whether the House and Senate reports included earmarks. Dr. Milliken replied that the House report includes \$16.4 million for hydrogen and fuel cell earmarks, while the Senate report includes about \$4 million in hydrogen and fuel cell earmarks. She added that both reports also include earmarks with general titles (e.g., "renewable energy") that may end up being funded out of the hydrogen program budget, so it is currently unclear what the total earmarks will be. She also reported that the Senate bill includes language stating that earmarks will be funded with additional money. This language is not included in the House report. The final conference report may resolve some of these issues. Vice Chairman Walker asked Dr. Milliken how this earmark allocation compared to past years. She answered that in past years (except for 2007, which did not have any earmarks because the budget was under Continuing Resolution) the EERE earmarks had totaled about \$40 million, twice the proposed earmarks in the 2008 budget. A participant asked when the final FY08 budget would be released. Dr. Milliken replied that the soonest they could expect a conference report from Congress would be after the August recess in September, but that there is a chance that the FY08 budget would go to a continuing resolution and continue at FY2007 levels. Mr. Wooten asked whether any of the budget documentation shows a finer level of detail (e.g., how the funding is allocated to projects within the production subprogram). Dr. Milliken replied that the budget does not provide this level of detail. The Multi-Year R&D Plan for the program does, however, list the R&D partners that are involved in the R&D in each key area. In response to a request from Mr. Wooten, Dr. Milliken agreed to prepare a budget summary for the HTAC that shows how the funding is allocated within the subprogram areas (with allocations shown by production pathway in the hydrogen production subprogram). Mr. Wooten suggested that the Committee may want to consider whether they understand and agree with the budget allocations and whether the pathways selected are, in fact, the ones to be pursuing.

Mr. van Dokkum observed that the President's original intent was a \$1.2 billion program. The actual net funding of the program (appropriations minus earmarks) has been \$725 million over the period FY04-FY07, leaving about \$500 million to be funded in 2008 in order to meet the President's goal. He felt that "if there was a strategic focus of the administration to implement a \$1.2 billion program, we're far short of the strategic intent." Dr. Milliken explained that the DOE hydrogen program does its best to work with the earmarked projects to help them address program goals. The participants discussed the total amount of earmarks that the program has incurred over

the period of FY04-FY07, and whether these have prevented the program from achieving the objectives of the Office of Management and Budget. Vice Chairman Walker observed that a key question is whether the Congressional appropriations have in fact fulfilled the objectives for the program that were laid out by the Office of Management and Budget. Dr. Milliken noted that there are some earmarked projects that do not address program goals, but she does not know how much of the budget these represent. In response to a request from Mr. Purtle, Dr. Milliken agreed to provide the HTAC with an accounting of the Hydrogen Program earmarks prior to FY07, but noted that it would be difficult to determine how many or what percentage of the funding does not address the program's goals (some projects clearly do not; others do, but are duplicative of competitively selected projects; large projects may have portions that address program goals and portions that do not; etc.).

Mr. Rose commented that while examining the past is useful, he wanted to make sure the HTAC's agenda includes an examination of the future budget. He noted that the President proposed a ten-year program but only funded five years of it. He asked whether DOE could share its out-year budget projections for the Hydrogen Program with the Committee. Dr. Milliken said that DOE cannot share the 2009 budget request until the President submits his request to Congress in February 2008. Chairman Lloyd asked if she could share information on the future budget trend. Dr. Milliken noted that they can, to some extent, share information on trends within key activities but that this information is not conclusive until the budget is released. Mr. Rose asked if the Committee could have access to the budget information privately, given their status. Dr. Milliken did not think she could distribute this information, but said she would inquire. Mr. Wootten asked if there was a ten-year projection in the public domain (like there is for the Fossil Energy program), and Dr. Milliken said that there is not. Vice Chairman Walker commented that the Congressional Budget Office produces some ten-year projections for its budget planning, but that these do not necessarily reflect the administration's point of view.

Mr. van Dokkum reiterated his two key points. First, that he believes that earmarks disrupt the strategic agenda. Second, he believes that the Committee should urge the administration, and especially the Secretary, to achieve the strategic plan the President set out at the beginning of his administration.

Dr. Shaw agreed with Mr. Rose that the Committee should focus more on future budget levels, rather than worrying about past earmark levels. He suggested that the Committee focus on whether a budget of about \$200 million is adequate going forward. Dr. Shaw proposed that the Committee take up this subject at a meeting in the near future, noting that since 2008 is an election year, the budget could easily be under continuing resolution well into 2009. He expressed concern that the program could be under-funded by Congress and urged the Committee to send a message that this should not happen. Mr. van Dokkum agreed that the Committee should make it very clear that they are concerned that the funding is provided to achieve the President's strategic plan.

3. Discussion of the Hydrogen and Fuel Cell Interagency Task Force

Chairman Lloyd announced that the Hydrogen and Fuel Cell Interagency Task Force (ITF) will hold its first meeting on August 1, 2007. He noted that he, as Chairman of HTAC, will have an opportunity to provide the ITF with input on what the Committee believes their focus areas and priorities should be. He observed that a year had passed since the Committee recommended the formation of the ITF. Dr. Shaw asked how frequently the ITF was going to meet. Dr. Milliken said that meeting frequency was a discussion topic on the ITF meeting agenda. Chairman Lloyd asked whether Assistant Secretary Karsner would be attending the ITF meeting. Dr. Milliken responded

that the Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy (Mr. John Mizroch) was delegated to attend and chair the meeting because the Assistant Secretary was unavailable. Chairman Lloyd reacted to this news with concern and disappointment, saying that the switch was inconsistent with the Committee's recommendation for Assistant Secretary-level participation and would be setting a poor precedent. Vice Chairman Walker asked whether the other participating departments would be sending Assistant Secretary-level representatives. Dr. Milliken answered that it varied by department. She explained that the DOE was "going after high-level people who can make an impact on agencies being early adopters of the technologies." Vice Chairman Walker said that the Committee expected to see people in the ITF who have policy-making power, and these people were typically at the Assistant Secretary-level or higher. Dr. Milliken assured Vice Chairman Walker that the Principal Deputy Assistant Secretary is "certainly one of those people who can take a recommendation back to the Department and make it happen...he has the ear directly of the Assistant Secretary." Looking at the list of the other members, Dr. Milliken is confident that all of them are in that sort of position. She stressed that the Hydrogen Program worked hard to get the highest-level and most appropriate people they could, and the program thinks it has an exemplary group. Chairman Lloyd wanted to communicate the Committee's disappointment that their recommendation was not fully realized. He also requested that the HTAC receive a list of all the ITF members and their positions (including any designated attendees for the August 1 meeting) by the afternoon of July 31, 2007.

Dr. Shaw recommended that Dr. Lloyd, in his comments to the ITF, focus heavily on the issue of "clearing the regulatory codes and standards logjam," since that is a place where senior members of the administration can be very helpful. He suggested that the first step is helping the ITF members to understand the problem; then they can work towards finding ways to streamline or accelerate the process. Vice Chairman Walker agreed, but also wanted to stress the importance of federal acquisitions as an ITF focus area, in order to share information and create synergies that facilitate increasing procurements of hydrogen and fuel cell technology by the federal government.

Dr. McCormick asked whether representatives from the Department of Homeland Security and the Department of Treasury had been identified, due to their respective interests in distributed networks and tax policy. Dr. Milliken noted that her team was still looking for suitable representatives from three agencies: Department of Homeland Security, Department of Treasury, and the Department of the Interior (National Parks/Bureau of Land Management). In response to a question about ITF members' experience with hydrogen and fuel cells, Dr. Milliken responded that there will likely be a learning curve for ITF representatives from agencies that do not currently conduct any work in hydrogen or fuel cells. She said that her office could supply background information on the technology for ITF members who need it.

Mr. van Dokkum suggested that one goal of the ITF should be measurement of progress in federal acquisitions, including what funding levels are available and what funds are expended for hydrogen and fuel cell procurements. He asked for more information on the current deployment programs that are underway. Dr. Milliken explained that some progress on this has already been made through the Interagency Working Group, and outlined a few examples for the Committee (National Weather Service planned solicitation for fuel cell-powered sensor arrays, Defense Logistics Agency procurements of fuel cell forklifts). She committed her team to assemble a table summarizing the current federal deployment projects. Dr. Dresselhaus asked whether the DOE was working with the National Institute of Standards and Technology (NIST) on purity standards. Dr. Milliken answered that DOE is working with NIST on codes and standards, as well as fuel cell testing and characterization.

Several Committee members agreed that it is critical for each member of the ITF to understand why his or her agency was invited to participate so that they understand what their role is and how they can contribute. Dr. Milliken agreed and offered to include a description of each organization's anticipated role in the ITF Member List that is being prepared for the HTAC. She also noted that each of the ITF members has been asked to speak for five minutes on what they are doing in the area of hydrogen and fuel cells and if they have any suggestions on what the ITF should focus on.

Dr. Milliken proceeded to review the ITF meeting agenda: 1) opening remarks from Mr. John Mizroch, DOE Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy, 2) overview of the Hydrogen Program from Dr. Milliken, 3) five-minute presentations from each of the ITF members, 4) HTAC presentation by Dr. Lloyd, and 5) open discussion of task force mission, priorities, objectives and meeting schedule. She informed the Committee that the ITF meeting attendees had been given prior notice about being asked to speak, and that some members had come to her team for background information. Vice Chairman Walker voiced his opinion that these presentations may be the most valuable component of the first ITF meeting. Dr. Milliken acknowledged that, due to a delay in getting the invitation letters out, the ITF members did not have a lot of advance notice about the meeting, so some of them were unable to attend or perhaps are not as well-prepared as they would have been with more ample notice. She committed her team to get the notices out quicker for the next ITF meeting.

After a brief five-minute break, Chairman Lloyd recognized Mr. van Dokkum. Mr. van Dokkum stated that he was speaking for himself, as the President of a company and as a person who is giving his all to further the future for hydrogen and fuel cells. He expressed his extreme frustration with "the lack of involvement and the lack of strategic direction and participation of some of the decision makers in [Washington, D.C.]." He questioned whether the HTAC was being taken seriously. He was particularly disappointed that the Assistant Secretary would not be attending the ITF meeting, when the meeting had been in planning for some time. He suggested two near-term actions for the HTAC to pursue: 1) after the HTAC submits its letter report to the Secretary, schedule face-to-face meetings with the leadership of both the House and Senate hydrogen and fuel cell caucuses to update them on the progress of the HTAC; 2) follow up with letters to Senator Bingaman and Congressman Dingell. He stated that these communications should convey that the HTAC does not feel it is "getting a lot of traction, and we question if the priorities are aligned with the objectives of the administration." He stated that if these letters do not result in increased responsiveness and involvement from decision-makers that he would personally consider resigning from the Committee.

Chairman Lloyd sympathized with Mr. van Dokkum's frustration, and he and Vice Chairman Walker agreed that meeting with members of Congress was a good proposal. Vice Chairman Walker noted that he was not as pessimistic about the process, and he pointed out that the legislative process can be slow and requires a long-term view. He stated that despite the fact that he, too, would like to have higher level participation in the August 1, 2007, ITF meeting, the very fact that agencies are currently preparing someone at a relatively high level to come to the meeting and speak about hydrogen is, in fact, a step in the right direction. He added that the Committee's job is to communicate that it wants that activity to proceed at a consistently high level, and meeting with Congress will convey that we are serious about pursuing policy objectives. Mr. van Dokkum agreed, but he noted that it is the leadership of any organization, public or private, that sets the tone for how urgently any issue should be pursued, and that the absence of that leadership sends a message that was not intended when the Committee recommended the Interagency Task Force. Mr. van Dokkum pointed out that he is on a European hydrogen and fuel cell task force, and that the group there has a lot of traction in policy development and R&D strategy development and seems to be taken much more seriously by officials. Dr. Shaw argued that the Committee members should not give up too

quickly—he encouraged them to speak out and continue working together because he believes that as a group the Committee could have a forceful role in bringing the hydrogen transition to pass. Chairman Lloyd echoed Mr. van Dokkum’s disappointment, saying that his optimism after the last HTAC meeting was undermined by the fact that Assistant Secretary Karsner was not able to attend the ITF meeting despite plenty of advance notice, and Dr. Lloyd speculated that Mr. Karsner’s absence could be a reflection of the overall priorities set by DOE leadership. He stressed that the challenges the country faces—energy security, energy diversity, environmental issues, climate change, and competitive businesses—are urgent and require a high level of commitment from government leaders. Dr. Lloyd also voiced his strong feelings that HTAC should not settle for baby-steps, considering the Committee’s congressional mandate, but instead should hold the Secretary accountable for his prior statement of support.

Dr. Dresselhaus observed that to get attention in Washington, DC, one must do something or produce something to warrant attention. She said that once the HTAC’s letter report is submitted to the Secretary, the response will be telling. The Committee members again expressed their disappointment that Assistant Secretary Karsner was sending a delegate to the ITF meeting in his place. Dr. Milliken reminded the Committee that while Mr. Karsner was unable to attend the meeting because of a scheduling conflict, he is still an ITF member. Chairman Lloyd closed the discussion by saying that the Committee would review the list of ITF members and actual attendees for the August 1 meeting and then consider the possibility of writing a letter to the Secretary expressing any concerns.

4. Briefing on DOE Well-to-Wheels Analysis

Dr. Milliken introduced Mr. Fred Joseck, DOE/Hydrogen Program Technology Analyst, to speak about the well-to-wheels analysis of hydrogen pathways performed by DOE and why and where the results may differ with other analyses (e.g., analyses conducted by the National Academies). She also introduced Dr. Michael Wang of Argonne National Laboratory, the lead analyst working on the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model. Mr. Joseck and Dr. Wang’s presentation may be found at http://www.hydrogen.energy.gov/pdfs/htacjuly07_well_to_wheels.pdf. Mr. Joseck noted that much of the data used in the DOE well-to-wheels analysis is publicly available through the hydrogen analysis resource center (http://hydrogen.energy.gov/resource_center.html). The energy price sets used (for oil, natural gas, electricity, etc.) are strictly sourced from the Energy Information Administration. The DOE well-to-wheels analysis integrates three DOE-funded modeling tools—GREET, H2A Production and Delivery models, and PSAT (Powertrain Systems Analysis Tool) to calculate projections for hydrogen cost, petroleum use, greenhouse gas emissions, and other key factors.

Dr. Wang noted that the GREET model, which estimates emissions of greenhouse gases and criteria pollutants from different energy pathways and vehicle technologies, is publicly available at <http://www.transportation.anl.gov/software/Greet/index.html>. There are over 3,500 registered users of GREET worldwide. Mr. Wootten asked Dr. Wang to confirm his understanding that the H2A model generates the capital and operating costs and final cost of delivered hydrogen, which is input to the GREET model for deriving emission scenarios, energy use and greenhouse gas emissions. Dr. Wang confirmed that the GREET model does not perform cost calculations. Dr. Dresselhaus asked whether renewable energy sources are included in the GREET model; Dr. Wang responded that they are, and stated that there are more than 100 fuel production pathways in GREET from various energy feedstocks for various transportation fuels (including hydrogen). Vice Chairman Walker noted that the single largest greenhouse gas is water vapor and that the

production of hydrogen produces water vapor. He asked why GREET does not calculate water vapor emissions. Dr. Wang clarified that the amount of water vapor created from production of hydrogen (or combustion of any fossil fuel) is much less than the amount of water vapor naturally present in the atmosphere, so it is generally considered by the scientific community to be an insignificant source of anthropogenic greenhouse gas emissions. Mr. Purtle asked where solar energy could be found on the output graphs from GREET. Dr. Wang pointed to the “Other Renewable” category, and explained that solar energy was included in that designation.

Mr. Joseck reviewed the H2A Production and Delivery models, which were developed by DOE in partnership with industry to improve the transparency and consistency of hydrogen analysis efforts, to understand differences among analyses, and to enable industry to contribute to and validate modeling assumptions, including cost factors. The H2A analysis (a discounted cash flow rate-of-return analysis) will be used to guide portfolio development and to provide direction for R&D activities. Its outputs include the levelized selling price of hydrogen required to attain a specified rate of return from different hydrogen production and delivery pathways, as well as tornado charts that help to identify the key sensitivities. Mr. Joseck described the key financial parameters in the model, and the model’s basic inputs and outputs. Inputs include detailed breakdowns of capital and operating costs.

Vice Chairman Walker asked if similar cost and well-to-wheels analyses are being conducted for other energy options, such as cellulosic ethanol, to facilitate comparisons between various alternative fuels. Dr. Milliken answered that EERE performs analysis to assess the oil savings and CO₂ emissions reductions and the cost of various technologies in the entire EERE portfolio. She added that the other EERE offices do not use the H2A model specifically, since they have their own analysis models. Mr. Wooten advised the Committee that the H2A model, including a user guide, and detailed assumptions and results, are available for download online, for anyone interested in experimenting with them. (See http://hydrogen.energy.gov/h2a_analysis.html). He complimented DOE on the accessibility and usefulness of the H2A information, and for the huge amount of data that is made available. Mr. Wooten registered a complaint, however, that he could not locate some of the references listed for data in both the Hydrogen Posture Plan and the HFCIT Multi-Year RD&D Plan. Dr. Milliken said that DOE will look into this and fix it so that all the reference sources are accurate and up to date.

Mr. Walker observed that comparative analysis will be very useful in order to compare the well-to-wheels costs, energy use and emissions from different technologies (e.g., ethanol-fueled and hydrogen-fueled vehicles). Mr. Joseck agreed, and said that the model does just that by putting the different vehicle technologies on an equal playing field. Dr. Shaw asked about the assumed costs of carbon sequestration. Mr. Joseck answered that while costs for carbon sequestration are factored into the model, the cost at \$15/ton is probably too low. DOE is currently working on developing a more robust analysis of carbon sequestration costs and will include these in a future version of H2A. Mr. Joseck noted that H2A in general is in the process of being updated. Dr. Shaw asked whether the transportation and disposal/storage of nuclear waste was factored into the H2A model; Mr. Joseck replied that these costs are not included in the model.

Asked about the comparison between “current” and “future” cases in the well-to-wheels analysis results slides, DOE responded that the current case is technology status as of 2005 and the future case assumes that DOE’s R&D targets are met for all technologies. Dr. Wang noted that the results slides show that the hydrogen fuel cell vehicle option almost totally eliminates petroleum energy use. In terms of greenhouse gas emissions, he noted that the results slides show that the hydrogen pathways do significantly reduce greenhouse gas emissions, with renewable pathways generally providing the greatest benefit. Chairman Lloyd and Dr. Shaw asked why the

greenhouse gas emissions were so high for the distributed wind electrolysis hydrogen fuel cell vehicle case. Dr. Wang explained that it is assumed for this case that the electricity for electrolysis is supplied by a combination of grid and wind power. Dr. Lloyd suggested that DOE should footnote this result to clarify that the greenhouse gas emissions are primarily a result of grid-provided power, and that options such as wind-solar would result in near-zero GHG emissions. Others in the Committee agreed that it is important to communicate these assumptions in the presentation itself so that people do not misinterpret the information that is presented. Mr. Joseck noted that the Hydrogen Posture Plan appendices do provide fairly detailed assumptions and footnotes for all the well-to-wheel cases. Dr. Milliken agreed that some of the key assumptions could be presented on a separate slide within the briefing. Asked about the emission assumptions for carbon sequestration, Dr. Wang noted that the coal case assumes 85% of the carbon in coal is sequestered (adding that this result does not imply that carbon capture technology is/will be actually be commercially available by this point). Mr. Joseck explained that one of the key reasons for the decrease in GHG emissions over time in the central biomass and coal hydrogen production pathways is the assumption about hydrogen delivery. In the “current” case, the model assumes delivery of liquid hydrogen via truck, whereas the “future” case assumes gaseous hydrogen pipeline delivery, which is more energy-efficient.

Chairman Lloyd asked about the fuel economy assumptions, and whether these were consistent with the potential increases in CAFE standards that are currently being considered. Dr. Wang replied that the GREET model does not make any assumptions about future policies that could affect CAFE standards. He pointed out that the data for fuel economy is based on “on-road” fuel economy, not “lab-tested” fuel economy, so the numbers may seem a little lower than expected. Dr. Shaw asked why the total energy use for ethanol production from cellulose was so high. Dr. Wang explained that this figure includes the energy for harvesting and delivering the biomass. He noted that because corn is a grain product and not an energy product, the energy for harvesting the corn is not included in the corn ethanol case. He argued that the Petroleum Energy Use figures are generally a more reliable indicator of emissions impacts than Total Energy Use, and are more consistent with greenhouse gas emission results. Asked whether the analysis includes energy or greenhouse gas emissions associated with constructing nuclear power plants, Dr. Wang responded that the analysis does not consider the construction phase—in all cases it only considers the “operation-related” activities for the hydrogen production plants. He pointed out that analysis has shown that construction-related energy use over the lifetime of a facility is very minor.

Mr. Joseck then explained some of the key differences between the DOE and the National Academy of Sciences (NAS) analyses (NAS report “Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs”). In the case of greenhouse gas emissions estimates, one key difference is that the NAS only includes emissions from the production of hydrogen, and did not factor in the energy emissions from delivery or feedstock production, as is done in the DOE/ANL well-to-wheels analysis. For current fuel economy of fuel cell vehicles, the DOE uses 57 miles per gallon of gasoline equivalent, whereas the NAS used 65. For the central biomass gasification case, the NAS assumed 70% production efficiency; DOE assumes 45%. For central coal gasification, the key difference affecting hydrogen production costs is that the NAS study used a very large capacity (1.2 million kilograms of hydrogen per day versus the DOE assumption of 300,000 kg/day). For both the central biomass and coal cases, DOE includes costs, energy consumption, and emissions from liquefaction and liquid truck delivery in the near-term and gaseous pipeline delivery in the longer term (whereas NAS assumes gaseous pipeline delivery in its analysis of hydrogen cost).

Vice Chairman Walker asked about the differences between DOE and NAS estimates for biomass gasification production efficiency. Mr. Joseck explained that the GREET model and the NAS study differed on multiple fundamental assumptions, including the type of equipment used for biomass gasification and the production scale. DOE's analysis bases its efficiency data on an indirect (Battelle) gasifier and a rate of 155,000 kilograms of hydrogen per day whereas the NAS analysis used a higher cost oxygen-blown (Shell) gasifier and a rate of 24,000 kg/day. Mr. Joseck noted that the DOE conferred with the national labs and its "Key Industrial Collaborators" (KIC) team to select the most appropriate technology and to develop the efficiency estimates. Mr. Wooten noted that the Shell gasifier is one of the most expensive commercial gasifiers available. He asked whether the Battelle gasifier is commercially available and Mr. Joseck responded that it is. Chairman Lloyd asked whether these differences would be resolved in the upcoming NAS study. Dr. Milliken said that she is not sure, but that DOE has briefed the NAS on these results, so they are aware of the differences in the assumptions.

Dr. McCormick expressed his concern that a complex, non-linear system like the entire hydrogen economy cannot accurately be modeled; there are many interactions and factors that are difficult to capture, simplify and quantify (e.g., the affect of water and land availability on ethanol production; the quantity and availability of natural resources; etc.). He worried that people in the policy arena who may not have an understanding of all the complex assumptions that underlie the models could draw erroneous conclusions. Dr. McCormick observed that decisions are often influenced by a lot of factors that are outside the "linear" model, and that these results may give the impression that we can simply pick and choose the "right" answer. He added that this sort of analysis does not capture what he views as one of the key benefits of hydrogen: its adaptability to unanticipated events and other "nonlinearities," since hydrogen can be produced from so many different fuel sources that can be optimized to each location. Mr. Joseck responded that this is one of the reasons why so many pathways are addressed within the model and why the assumptions are clearly described. Mr. Purtle commented that this type of engineering analysis is a necessary first step; further analysis should also be done to look at the kind of strategic questions that Dr. McCormick is considering. Mr. Joseck stated that the H2A and GREET analysis allows researchers to break down the costs of each pathway, enabling the program to evaluate progress against targets and focus its research dollars on the key technical "bottlenecks." Mr. Bawden asked what the next level of analysis would be. Mr. Joseck replied that the H2A model would be expanded in two ways: 1) to incorporate stochastic or probability analysis to better understand and model capital costs and cost reductions and 2) an improved cost analysis for carbon sequestration. Mr. Joseck noted that sensitivities in things like the cost of hydrogen pipeline materials will be considered in the stochastic analysis.

Mr. Joseck closed by saying that the analysis shows that hydrogen can be very cost-competitive with gasoline and hybrid electric vehicles, even using the 2005 Energy Information Administration (EIA) "high oil case" price set with gasoline at \$1.29/gallon, and can produce significantly less greenhouse gas emissions. He noted that the DOE offices (EE, FE and NE) will continue to work together to understand and refine the modeling assumptions, and that an effort to do this internationally is also underway (which is the subject of his next presentation). Vice Chairman Walker asked whether the model has been run with \$2.50/gallon gasoline, instead of the \$1.29/gallon used in the model. Mr. Joseck replied that DOE has run that analysis, and that this makes hydrogen more cost-competitive.

Dr. Shaw suggested that one activity the HTAC could pursue is working with DOE to run the models with some assumptions and ranges that would highlight key sensitivities and then present these results to Congress in a format that they would be able to understand. He suggested that what is needed is condensed, simplified information with clear comparisons that are supportable

with solid assumptions. Mr. Purtle agreed, noting that the driving sensitivity is the cost of gasoline. Vice Chairman Walker suggested that some of the charts in DOE's presentation are already very useful in communicating key messages about the environmental and energy benefits of hydrogen: e.g., the petroleum energy use chart. Mr. Wooten noted that there is a technical advisory group comprised largely of industry representatives that has contributed to and reviewed all of DOE's assumptions already. He believes that HTAC can add the most value by evaluating the pathways and considering whether the research dollars are going towards those that are meeting program goals. Dr. Shaw agreed with Mr. Wooten, but reminded him to not forget Dr. McCormick's earlier point about the risk of drawing conclusions from engineering analysis that does not take into account all the nonlinearities. He also noted that the model does not yet capture the costs of carbon sequestration, etc., so we do not yet have an understanding of what the full costs are. Mr. van Dokkum wondered whether it would be possible to look at analysis being conducted worldwide—in the U.S. Canada, Europe, Asia, etc.—and see if there is any convergence on recommendations for particular pathways and focus funds on developing those three or four solutions that the community at large feels have the most promise.

Before breaking for lunch, Ms. Epping noted that the HTAC had been provided with a mark-up of the draft letter report to the Secretary, which includes all the comments received from HTAC members prior to the July 31 meeting. The HTAC was also provided a copy of late comments received from Mr. David Friedman and comments from Dr. Kathy Taylor and Dr. Byron McCormick, as separate documents.

Afternoon Session: July 31, 2007

5. DOE Progress Report on Fuel Cell Learning Demonstration

Dr. Milliken distributed the *Energy Washington* article about the NREL interim report on DOE's Learning Demonstrations, as well as a DOE-prepared summary of the highlights of the NREL report. She noted that the first phase of the learning demonstration (which is testing vehicles with first-generation fuel cells and storage systems using late 1990s or early 2000 technology) is reporting fuel cell vehicle system efficiencies of 52.5 to 58.2%, very close to DOE's 2010 target of 60%. For durability, Dr. Milliken reported that the vehicles have averaged 700 hours, with a high of 1,250 hours from one of the teams in the project—this range straddles the 1,000-hour DOE target. She also reported that in the laboratory, researchers are reporting 5,000 hour durability using accelerated testing on more advanced membranes and membrane electrode assemblies. The 5,000-hour mark is equivalent to 150,000 miles and is DOE's 2015 target. She stated that DOE is very satisfied with the progress on durability to date and is confident that long-term targets will be met. Dr. McCormick concurred, noting that though 5,000 hours cannot yet be proven in a real vehicle, testing on new technology indicates that this target can be met. Dr. Milliken reported that fuel economy results in Phase One have ranged from 42 to 56.5 miles per gallon of gasoline equivalent, and that the vehicle driving range is 103-190 miles (the 2009 DOE target is 250 miles). The average refueling time is 0.71 kilograms/minute (the target is 1.0 kg/minute). When asked by Dr. Lloyd whether any of these results include data from Nissan, Honda or Toyota, Dr. Milliken said that data is only from participating companies in the learning demonstration: Hyundai, Ford, DaimlerChrysler, and General Motors. Dr. Shaw asked DOE to provide the DOE summary to Dr. Ramage so that he could review it and circulate it to the NAS review committees. The summary, "DOE Publishes Progress Report on Fuel Cell Learning Demonstration," is posted at <http://www1.eere.energy.gov/hydrogenandfuelcells/>

6. HTAC Members' Preparation of the Posture Plan Review Report to the Secretary (Part I)

[The discussion of the letter report to Secretary Bodman included many grammatical and editorial comments; only the broad-reaching discussions and prominent comments are included in these minutes.]

Dr. Shaw referred the group to Dr. Ramage's general comment that the Committee should not use "overly positive statements" when referring to the future of hydrogen. The Committee (especially Dr. Shaw, Mr. van Dokkum, and Chairman Lloyd) considered this perspective and the danger of over promising or becoming "cheerleaders," and agreed on usage of the wording, "hydrogen has the *significant potential to...*"

Vice Chairman Walker spurred a discussion about better communicating hydrogen's many benefits, including its ability to be produced in a distributed fashion and by using off-peak power, or intermittently available renewable resources such as sunlight. The members of the Committee felt conveying these multiple benefits were paramount to the hydrogen message, and included wording that "hydrogen has the ability to store energy from intermittent renewables or during off-peak power periods."

Dr. Roger Saillant's comments on the letter sparked discussion on hydrogen's relationship to other renewable energy sources. He conveyed his desire not to tout hydrogen as the panacea, but as a part of a systemic approach to addressing energy needs in a "petroleum constrained environment."

Dr. Shaw noted that the letter should not speak about fuel cells or hydrogen independently of one another, but the two working in tandem. Dr. McCormick and Chairman Lloyd voiced approval and the Committee concurred. This change was applied to the letter at large.

Chairman Lloyd set a goal to deliver the completed letter to Secretary Bodman by the end of August. Dr. Milliken and Ms. Epping approved of this timeframe, saying that the more time Secretary Bodman has to prepare his response, the better.

Dr. Dresselhaus asked for an explanation of what "the transition" is. After some discussion, led by Mr. Vesey and Vice Chairman Walker, the Committee changed the wording to "this transition." This change, although seemingly minor, is intended to convey the Committee's understanding that the transition is from the present period of very low volume, high-cost fuel cells to a more technologically mature situation with robust markets and consumer choices. Mr. Walker noted that this transition may not necessarily represent "the (ultimate) transition" to carbon-free fuels, but it would represent a significant change in the energy economy and the direction that it is heading.

Vice Chairman Walker noted the "political saliency" of the goal of reducing "imported oil" use as opposed to just "oil" use. He conveyed his opinion that the national security issues are largely associated with imported oil. Dr. Shaw noted that decreasing U.S. dependence on imported oil was specifically in the HTAC charter. Thus, the Committee members agreed to stay with the wording "...efficient energy systems that do not rely on imported oil..." Similarly, Vice Chairman Walker wanted to change a sentence relaying the position of the U.S. from "a leader" to "the leader," to better convey the sense of the Committee that the U.S. should reclaim its leadership position in this technology area. The Committee agreed to this change.

When the budget recommendation for hydrogen was discussed, Dr. Saillant argued that the target should be the \$3.73 billion authorized in EPACT, which has not been fully appropriated. After discussion among the group, it was agreed that the language would be restricted to the hydrogen budget and would say that “funding for the hydrogen programs should be increased to at least the \$3.73 billion authorized by EPACT...”

Mr. Wooten questioned a suggestion to specifically call out the need to increase funding for “renewably generated hydrogen,” saying that he was not comfortable with placing a major thrust on renewably generated hydrogen since there is a suite of technologies available for hydrogen production. He believes that in the near term we will see quicker, better results with some of the other technologies. It was agreed to add a statement about the need to increase “efforts on renewably generated hydrogen” so that it was associated with the need for more exploratory research in the area. After discussing stationary, portable, and micro fuel cell applications, the Committee decided to include a sentence regarding funding federal procurements of these fuel cells in alignment with what is called for in EPACT, and a sentence that supports development of financial and regulatory incentives for hydrogen and fuel cells. The Committee also adopted a suggestion to include a reference to “current tax credits” as an example of a financial incentive that the Committee would support; some members emphasized that the extension of current fuel cell tax credits will be critical for the industry. The Committee members noted, however, that “incentives” is a broad recommendation that should allow for diverse policy actions for both technology producers and consumers.

In discussing the recommendation on the Technology Validation subprogram, the Committee added wording to include demonstrations of fleet, stationary, and portable power applications, making clear that both large-scale and small-scale (distributed power) fuel-cell systems are desired in stationary applications.

At this point, the Committee agreed to postpone its work on the letter report in order to hear Mr. Joseck’s briefing on international analysis efforts.

7. Briefing on International Analysis Projects

Mr. Joseck presented an overview of DOE’s activities in international collaboration on hydrogen analysis (see http://www.hydrogen.energy.gov/pdfs/htacjuly07_collaboration.pdf). He reported that DOE is currently active in two key projects in this area.

The first project is a joint effort between the International Energy Agency (IEA) and the International Partnership for the Hydrogen Economy (IPHE) to convene public and private sector stakeholders to investigate the global infrastructure requirements, opportunities, and challenges for a hydrogen economy in different countries and regions. The project includes three workshops to gather input and share information among the global community with a final report to be prepared in early 2008. The first (North American) workshop was held in Detroit, Michigan in April 2007; in July 2007 the European-African workshop was held in Paris, France; and on October 24-25, 2007 the Asia-Pacific Rim workshop will be held in Shanghai, China. Mr. Joseck stated that one goal of the project is to share information among analysts working on modeling and analysis of hydrogen technology and infrastructure development, especially those models that help with transition analysis, planning, and policy development. Mr. Joseck noted that the workshop in North America focused heavily on transportation applications, whereas the workshop in Europe focused more on stationary applications. He also reported that in both workshops key themes included the need to educate the public and get the word out about

hydrogen, and the need for policy support to move technology into the marketplace. Dr. Shaw asked whether any HTAC members had attended the meetings in Detroit or Paris. Vice Chairman Walker responded that he attended the meeting in Detroit, but not in Paris, and had found the discussion to be quite creative. Mr. van Dokkum noted that he was at an executive meeting with the European Union (E.U.) that included a briefing on these activities, and he thinks it has been a very well done effort. Dr. Shaw asked Mr. van Dokkum whether the meetings generated any fresh ideas, and he replied that although few fresh ideas emerged, the modeling presentations were very interesting and indicated surprisingly low costs associated with building the infrastructure.

The second international project with which DOE is involved is collaboration through the IPHE to compare analysis approaches and models developed in Europe and the United States, and in other IPHE member countries. Mr. Joseck reported that the project will compare well-to-wheel (and other) modeling approaches, pathways that are relevant in each region, basic technical and economic assumptions, hydrogen pathway analysis results, and infrastructure analysis results. The project began in October 2006 and is expected to finish in October 2008. The models currently being compared include the European Union's E3database and the DOE's H2A Production, HDSAM (H2A-based delivery scenario analysis), and GREET models. Subsequent tasks will expand these efforts to include other European and U.S. models, as well as models being developed in other countries.

Mr. Joseck pointed out some of the key differences in financial parameters between the E.U. and DOE models: 1) DOE assumes 100% equity financing and E.U. assumes 100% debt financing; 2) DOE assumes corporate tax rates and E.U. assumes no taxes; 3) DOE assumes 15% working capital and E.U. assumes 0%; 4) DOE uses MACRS depreciation and E.U. uses straight line. Other key differences in the hydrogen production, delivery, and emissions analyses that have so far been identified are outlined in Mr. Joseck's presentation. Differences in fuel economy projections are also notable—the E.U.'s estimates tend to be much higher than U.S. estimates, because they use smaller cars and different drive cycles. He noted that this effort has been extremely useful and will likely lead to more consistency in international modeling efforts, and a better understanding of the differences in underlying assumptions. Dr. Shaw asked whether the different modeling efforts were planning to standardize their assumptions or work towards a common set of models. Mr. Joseck replied that the DOE will continue to use its models and the E.U. will likely continue to use the E3database. He noted that the models agree for the most part, and that the teams are working to understand the differences and make changes to improve the models where appropriate.

Mr. Joseck reported that as a result of the collaboration, the E.U. is considering modifying some of its financial parameters to include a return on investment. Dr. Shaw commented that the most important factor is the cost of capital, not whether it is equity or debt financing. Based on input from industry advisory groups and the European analyses, the DOE plans to reevaluate its estimates for biomass conversion efficiency (which is 45% compared to the EU estimate of 65%).

8. HTAC Members' Preparation of the Posture Plan Review Report to the Secretary (Part 2)

Mr. Wooten restarted the discussion of the letter report at page 5 ("Positive Features of the 2006 Posture Plan"). He stated that he saw too many references to renewable energy sources. He asserted that the Committee should look beyond the transportation sector, stating that renewables will not be able to meet the energy needs for the entire stationary power generation sector. He

expressed concern that an emphasis on renewables would de-emphasize the stationary side and he wants to ensure that the focus remains on a suite of technologies and approaches. The Committee subsequently agreed to some minor changes in the letter report that would delete several specific references to renewable energy.

Dr. Shaw asked for the breakdown in the DOE Hydrogen Program budget for hydrogen production. Dr. Milliken replied that in 2007, roughly \$20 million went to nuclear hydrogen production, \$20 million to coal-based, and about \$30 million to renewable hydrogen (excluding the delivery budget). Mr. Wooten reminded the HTAC that on the Fossil Energy side, there is also a large, separate, budget for carbon sequestration (\$80-\$100 million), large-scale coal gasification (\$40 million), and FutureGen. Dr. Milliken noted that on the renewable energy side, there are also related programs (e.g., in biomass, wind, and solar R&D) that support the hydrogen effort.

Dr. Saillant stressed the importance of a systems approach in the development of the hydrogen economy, and thought a look at the entire American energy picture would be worthwhile. He specifically wondered about the opportunities for energy efficiency improvements in all the sectors and how capitalizing on these would affect energy demand and, subsequently, the viability of different energy supply and infrastructure options (e.g., shrinking central power demand could increase opportunities for distributed power; increasing mass transit and CAFE standards could lower transportation fuel demand; etc.). He asked for references to any reports or studies that look at these types of harmonization and synergistic issues. Mr. Wooten suggested it might be useful for the HTAC to have a presentation from the Energy Information Administration on their energy use forecasts, including the “high technology case” and the baseline case, and how the assumptions for each case differ. Mr. Keuter referred Dr. Saillant to the Electric Power Research Institute (EPRI) report discussed at the May 2007 HTAC meeting, which found that a combination of energy efficiency, nuclear, renewable, advanced coal, carbon sequestration, and high performance vehicles (like fuel cells) are needed to solve the carbon problem. Dr. Saillant voiced his opinion that a future discussion on the role of public policy would be useful, since there appears to be some different opinions among the Committee members and the Committee’s position on these matters are strategically important and will impact their work.

Dr. Shaw suggested that the Posture Plan should explicitly address some of the “shocks and nonlinearities” that could alter the expectations and forecasts about future energy supply and demand. Dr. McCormick agreed, adding his support for talking about “options.” He believes a key goal should be the ability to exercise various options as future circumstances dictate, and argued that the modularity, flexibility, and adaptability of hydrogen production and delivery options is a key advantage of hydrogen as an energy carrier. To capture this discussion point, the Committee agreed to add a statement in its letter report to the Secretary that while the Committee commends the focus on component-level R&D, “development activities should be conducted in the context of broad systems operations and applications analysis.”

Moving on to the “Gaps and Areas for Improvement in the 2006 Posture Plan,” Vice Chairman Walker stressed the importance of the Committee’s recommendation that the Posture Plan should better define the government’s role in commercialization. Dr. McCormick suggested wording to better define the “valley of death” or “crossing the chasm” in the letter report. In his view, the valley of death is created by the lengthy lead time between significant investment outlays for technology development, engineering, manufacturing, and fueling infrastructure, and the recovery of that investment (which could take as long as 20 years in the case of fuel cell vehicle development). The Committee agreed to adopt this wording for the report.

Dr. Saillant pointed out that the success of the auto industry depended on the construction of roads and highways on which consumers could drive. He asserted that the decision to spend government money to build roads was made for the public good, and a parallel argument can be made for government support for development of a hydrogen infrastructure. Vice Chairman Walker added to this point, stating that as cars became more affordable and more people got them, public pressure for roads was what really motivated the government to act. Dr. McCormick brought up the example of the federal government's support for building the transcontinental railroad as another example of the government building infrastructure to meet a public good. He stressed that the international winner in the hydrogen economy will be the nation who figures out how to best blend public and private funds. He added that he saw the U.S. as perhaps the most disadvantaged because of the country's reliance on the free market. Mr. van Dokkum declared that the basic issue for the purposes of today's discussion is the recommendation that the Posture Plan needs to improve its discussion of government's role in commercialization and market transformation efforts; getting into specific policy recommendations would be too complex and controversial.

The Committee moved on to its recommendation that the Posture Plan present a broader vision of how hydrogen fits into the overall national energy strategy. After some discussion about whether to replace the words "hydrogen will be a key part of the energy mix..." with "hydrogen has the potential to be a key part..." the Committee agreed to stick with the more assertive, positive language and stayed with "will be." In response to Mr. Friedman's written comments asking for parallel treatment of renewable energy in this section, the Committee agreed to add a sentence: "A long-term goal is to increase the use of renewable resources to produce hydrogen in the future." The Committee also agreed to add wording stating that longer term R&D should focus on "development of renewable resources and other long-term technologies for maximum impact."

For the recommendation that the Posture Plan expand its scope to include more emphasis on stationary and portable fuel cell power applications, Mr. van Dokkum offered some edits that highlighted the reasons for including stationary and portable fuel cells and the roles that they would play in advancing the overall hydrogen economy. Dr. Saillant agreed that the linkages and synergies between vehicle and non-vehicle fuel cell systems need to be stressed in the Posture Plan.

The Committee moved to its recommendation that the Posture Plan should articulate a plan for a DOE leadership role in coordinating efforts to harmonize and expedite codes and standards. Dr. McCormick presented some suggested changes to the supporting text for the recommendation, which was adopted by the Committee. Mr. William Chernicoff asked whether the term "rulemaking organizations" in the recommendation language referred to state regulatory bodies or federal regulatory agencies, and the Committee replied "both." He noted that if the Committee recommendation implies DOE oversight of another federal agency's statutory regulatory authority, it would have to be discussed and agreed upon by policymakers. Dr. Milliken clarified that the Committee's recommendation suggests a DOE role in *coordinating* the multiple branches of government, not directing, and offered her opinion that this is an appropriate role for the Interagency Task Force (ITF). The Committee agreed to add that DOE should work through the ITF in this coordinating capacity.

Mr. Chernicoff expressed his disagreement with the Committee's original language that stated a "lack of federal regulations to enable the use of [portable hydrogen devices]." He expressed that regulations do permit the interstate movement of these devices and that significant progress has been made in addressing the use of these devices aboard airplanes. Mr. Bawden explained that, while portable hydrogen fuel cells and storage containers can be carried aboard airplanes, their

quantities of hydrogen are limited and they are considered dangerous goods, requiring training, special packaging, and auditing by government agencies. He sees this categorization as a hindrance to quick technology release and adoption. The Committee agreed to replace the term “lack of” with “constraint of,” and Mr. Chernicoff said he would check the text with his colleagues in the regulatory office at DOT. Mr. Chernicoff went on to stress that the hazardous designation is not exclusive to hydrogen, and pointed out that gasoline, natural gas, and batteries are also regulated under HAZMAT. Mr. Bawden replied that he would be satisfied if small hydrogen storage devices were on par with batteries. Dr. Shaw specified in the letter that the priorities for the regulatory expansion are transport and travel, especially in the air.

In discussing the recommendation for improved “well-to-wheels” analysis, the Committee agreed that this term does not apply very well to similar analysis for stationary systems. Therefore, they agreed to the term of “carbon analysis” for stationary applications. The Committee also adopted some additional language describing analysis for stationary systems. With regard to the recommendation for “analysis of strategies that evaluate the potential for reducing carbon emissions and oil imports through the development of a hydrogen economy,” there was some confusion about what this meant. After some discussion, the Committee agreed to add that the analysis should clarify the magnitude and timing of environmental impacts and oil imports through the development and implementation of a hydrogen economy under different pathways. Dr. Saillant argued that the assessment of “environmental impacts” should include some of the risk factors and unknowns that could be associated with things like nuclear waste disposal and carbon sequestration. Dr. McCormick stressed that the notion of analyzing “strategies” versus “scenarios” is important, and should reflect the notion that nobody can predict the “right” path because of the nonlinearities, but that options need to be evaluated.

The Committee agreed to leave the letter report’s closing paragraph as it was written and leave to the Chair and Co-Chair the option of revising the language to reflect the interest of the Committee in more face-to-face dialogue with the Secretary.

Chairman Lloyd closed the discussion and thanked the HTAC support staff for their help with synthesizing the Committee’s comments for the letter report to Secretary Bodman. Ms. Epping committed to provide the HTAC members with a hard copy of the revised letter report by 6:00pm for a final review overnight.

9. Overview on Hydrogen Prizes

Dr. Sunita Satyapal presented a short summary to the group on proposed hydrogen prizes (see http://hydrogen.energy.gov/pdfs/htacjuly07_prizes.pdf). She described the objectives for the prizes (accelerate progress, stimulate innovation, provide public visibility), noting that the prizes would be designed to complement the existing R&D program by seeking innovative solutions from researchers outside the current solicitation process. She noted that the creation of prizes would also be consistent with EPACK Section 1008, OMB interest in offering cash prizes for breakthrough R&D, and NAS recommendations for fostering innovation through prizes. She pointed out that EPACK Section 1008, subsection (a) authorizes the Secretary of Energy to award cash prizes for breakthrough research in any “grand challenge” area, whereas subsection (c) specifically authorizes the creation of “Freedom Prizes” for processes or technologies that reduce dependence on foreign oil. The prize program under subsection (a) is authorized at \$10 million and subsection (c) is authorized at \$5,000,000, although no funding has been appropriated. Dr. Satyapal noted that prize concepts are under development for biofuels and hybrid vehicles under subsection (c) and for hydrogen storage under subsection (a).

Dr. Satyapal went on to explain the H-Prize bills (HR-632 and S-365), which were introduced in 2006 (passing the House only) and reintroduced in 2007. She explained that the bills describe three technology categories for prizes: 1) technology advances in components or systems for production, storage, distribution, and utilization of hydrogen; 2) prototypes such as vehicles to meet a certain driving range; and 3) “transformational technologies” for hydrogen production or distribution. Categories 1 and 2 would be offered every other year, with total authorizations of \$20 million each over the period 2008-2017. Category 3 prizes would require private cost share, and are authorized at \$10 million in federal funding over the ten-year period. She explained that DOE would be required to work through an independent third party to administer the H-Prize. DOE is currently compiling lessons learned from other innovation prizes (e.g., the X PRIZE, Granger Prize, and the Centennial Challenge), and looking into some of the issues associated with developing and administering such a prize. She noted that the bill also requires DOE to consult with HTAC, the National Science Foundation, and other federal agencies on the criteria for the prize, so this may come up as an agenda item for the HTAC if the legislation is enacted.

Dr. Shaw asked who would administer the proposed DOE prizes. Dr. Satyapal explained that DOE has spoken extensively with other groups who have administered prizes in the past (e.g., DARPA, NAS, NASA, and the X PRIZE Foundation) for past experience. The DOE would also follow whatever statutory requirements exist in EPACT or the H-Prize legislation for administering the prizes. Vice Chairman Walker noted that in the past, prizes have sometimes been used as alternative methods of procurement rather than as opportunities to go after stretch goals. He cautioned that by setting targets that are too narrow or specific, it can prevent true innovation that creates brand new ways of doing things. He stressed the real value of prizes: stretch-goals that force innovation which might not have otherwise occurred. Dr. Satyapal pointed out another concern that has been raised, which is keeping the appropriations for the R&D program and the prizes clearly separate, and providing enough funding within the prize appropriation to cover both the cash prize and its administrative expenses. Dr. Milliken noted that so far the congressional language has provided flexibility to the DOE and the administrator on prize criteria, so it should be possible to set aggressive targets. Vice Chairman Walker noted that work towards the prize should push technology forward even if the prize is not won. Mr. van Dokkum reminded everyone that the HTAC had some discussion about the concept of hydrogen prizes at the May HTAC meeting, and he thought that the Committee had concluded that it did not want to endorse a prize scenario as a path forward. Dr. Shaw recollected that the Committee concluded that it did not have enough information to reach a conclusion, and had requested DOE to provide more advance information. Mr. van Dokkum noted that there are other topics within EPACT (e.g., the federal procurement program) that he would like the Committee to address if the HTAC is going to be considering the topic of prizes. Dr. Milliken clarified that DOE was not looking for an endorsement of prizes from HTAC, but was seeking to inform the Committee about current activities in this area. Dr. Dresselhaus stated that the DOE should examine how any new prizes would fit in with existing prizes (such as the Enrico Fermi Prize and the Lawrence Prize).

10. Update on the Hydrogen Executive Leadership Panel (HELP)

Mr. van Dokkum attended a recent HELP meeting in Atlanta, and spoke briefly about their impending reorganization. He noted that there appears to be consensus that the group needs to restructure itself to become more of an educational organization for firefighters, rather than a standards writing organization. The focus would be on providing training for firefighters and providing input from fire fighters to standards writing organizations. Mr. van Dokkum will

attend their next meeting on Hydrogen Safety in September or October. Dr. Saillant noted here that a standard has been developed that reduces the setback requirements for hydrogen devices from buildings to five feet, which is a big step forward (given that over the past four years the setback distance has gone from 30 to 15 to 12 feet, and now 5 feet). Mr. Rand Napoli added that as the standards continue to settle, the real challenge will become the adoption of those standards and codes for local officials. Mr. van Dokkum also reported that HELP selected the California Fuel Cell Partnership's training manual for firefighters as a guide for their own training materials, and will work with the Partnership to make this happen. Ms. Chris Sloane added that the DOE held training for permitting officials in association with the HELP meeting. She explained that the training was scenario-based and very interactive, and reported that the fire community was extremely enthusiastic about the training.

11. Status of Codes & Standards for Hydrogen Fueling Stations and Hydrogen Facilities

Ms. Chris Sloane from General Motors presented a briefing on the status of hydrogen codes and standards (see http://hydrogen.energy.gov/pdfs/htacjuly07_status_codes.pdf). She provided definitions of standards and codes, noting that standards are documents with technical requirements and recommended practices and codes are documents that cover a broad range of requirements for facilities (buildings). Standards will typically also include methods or procedures for testing and validation. She noted that standards are developed by standards development organizations (SDOs) such as the American Society of Mechanical Engineers (ASME), American Society for Testing and Materials (ASTM), Compressed Gas Association (CSA), etc. She explained that some codes require equipment whose compliance with standards has been verified by a third party (e.g., Underwriter's Laboratory). Ms. Sloane noted that codes can be adopted directly into law and many states draw them right into their building or fire codes without any modifications. Codes will *refer* to standards for the requirements of equipment and systems. Code development organizations include the National Fire Protection Association (NFPA) and the International Codes Council (ICC).

Ms. Sloane explained that the major codes have all been written to include provisions for hydrogen in them, but that most states have not upgraded to the new edition of the codes and so local permitting authorities may not be aware that there is code to cover hydrogen. She noted that the codes are not all perfect and probably will need to be revised and updated as more advanced technology comes out. She explained that besides the availability of codes, a key difference between today and the 1990s is that there is training available for many local jurisdiction authorities who want to come up to speed on hydrogen and there is a track record from demonstration projects that people can learn from. She also noted that private companies seeking permits are now much more experienced in getting permits, understand the complexity of the process, and commit the necessary staff resources to get it done. Ms. Sloane noted that there are still some gaps and issues, such as the lack of a standard for composite tanks at fueling stations, the recommendation in some codes for hydrogen odorants (which is not currently possible), incomplete standards for vehicle storage and fueling (expected to be completed by the end of 2007), etc. She also noted that the community is awaiting establishment of federal requirements for portable hydrogen-fueled devices on airplanes and revision of federal requirements for transport of hydrogen cargo. She added that in the absence of an established public track record, the ability to get liability coverage remains a substantial issue. However, she noted that there is a long record with hydrogen use, but that people do not know about it because it has not been in the public retail sector. She pointed out that risk is defined as the product of the probability of an adverse event and the severity of that event, noting that industry has traditionally done a very good job of minimizing the probability of serious incidents. She closed with a slide that

presented year-1875 excerpts from the *Congressional Record* describing the societal risks of making another major transition: the switch from horses to “dangerous and costly” gasoline-powered automobiles. She explained that it all has to do with experience and comfort level, and that today most people probably feel that it is less risky to get into a car than to ride a horse.

Mr. Bawden asked whether the codes and standards were getting so detailed that they were starting to drive design and restrict innovation. Ms. Sloane responded that while it is easier to develop prescriptive standards, the drive has been for performance based standards so that new standards do not need to be written every time new technology comes along. Chairman Lloyd thanked Ms. Sloane for her presentation and remarked that he was delighted to see such a positive message about the progress that has been made. Mr. Napoli gave additional positive news by reporting that at the last HELP meeting several oil company representatives reported a permitting time of nine months to a year for refueling stations. This was especially impressive considering the local permitting officials (fire and building) had never before permitted a hydrogen fueling station. The concern of the oil companies in many cases was no longer the permitting, but the zoning. Mr. Napoli answered a question from Chairman Lloyd by saying that a new station was much easier to permit than a new island on an existing station due to differences between hydrogen and gasoline setbacks and the like. Dr. McCormick applauded Ms. Sloane for her endless fight for performance-based standards and for her success in carrying the message.

12. Closing comments for the day from the Committee

Dr. Milliken distributed the list of Interagency Task Force members and the contribution that DOE expects each agency to provide. Ms. Epping distributed the final draft letter report to the Committee, with all the comments from the day incorporated. Mr. Katsaros asked if he could get electronic copies of all the presentations from the day, particularly Mr. Joseck’s, and Ms. Epping responded that DOE would get those to him. Ms. Epping also noted that the presentations would be posted to the HTAC website at hydrogen.energy.gov.

Dr. Dresselhaus suggested that the Committee include in its agenda item for “Other Business” the subject of what the HTAC will focus on after this letter report is submitted. She and Dr. Shaw noted that a number of different ideas have surfaced during the Committee’s discussions. They recommended that the HTAC support staff go through the minutes and make a list of all these suggestions. Dr. Lloyd reiterated his desire to follow through on the idea for a closed session with industry under non-disclosure agreements that provides HTAC with up-to-date information on the status of technology. Dr. Milliken noted that she had checked with DOE attorneys and a closed session does not seem to be possible. Dr. McCormick noted that the National Academy review committee has been briefed on some of the most recent technical information. Dr. Lloyd said that he would like to pursue the idea of a trip to General Motors and/or UTC by any Committee members who are interested in attending on their own, but not as members of HTAC. Both Dr. McCormick and Mr. van Dokkum said that they would be happy to host them. Mr. Katsaros also noted that he was contacted by a Honda representative who said they would make a presentation to HTAC if the Committee was interested. He added that what he heard from Honda about their progress was very surprising and encouraging to him. Dr. Dresselhaus expressed her desire for an action plan for finishing up the more detailed comments on the annotated Posture Plan, and suggested using the four groups to get this accomplished.

The Committee adjourned the July 31 meeting at 5:41 p.m EDT.

AUGUST 1, 2007

Day two of the meeting of the Hydrogen and Fuel Cell Technical Advisory Committee (HTAC) was called to order at 9:00 a.m. EDT by Dr. Alan Lloyd, HTAC Chairman. Fifteen HTAC members were present and eight members were absent (list attached).

13. Remarks from Deputy Assistant Secretary for Renewable Energy Steve Chalk

Chairman Lloyd introduced Mr. Steve Chalk, DOE Deputy Assistant Secretary for Renewable Energy.

Deputy Assistant Secretary Chalk thanked the HTAC members for their work and stated that he had recently looked over the Committee's draft letter report and agreed with its concentration on areas that were not addressed in the previous Posture Plan, such as policy and market transformation. He noted that his office has recently been focusing a lot of attention on responding to the President's announcement on climate change, which calls for a plan to address climate change by the end of next year. He stated that hydrogen is obviously a program that could have a huge impact in the long term on reducing carbon emissions. Mr. Chalk also noted that DOE presented budget testimony on July 31 on the biofuels program, and explained that Assistant Secretary Karsner is working towards modeling the operation of the biofuels program after the success of the hydrogen program. Another area that is receiving increased attention is the geothermal program, which the DOE is reevaluating in light of the MIT report on enhanced geothermal. He reported that members of his office recently made a visit to Iceland to talk with them about their work in geothermal and to explore partnership opportunities. Other activities that are being pursued to address climate change and energy security include hybrid and plug-in vehicles, and so on. Mr. Chalk noted that over the past year the program has also been investigating policies and activities that can be pursued to stimulate increased deployment of market-ready energy efficiency and renewable energy technologies.

14. Final Steps for the First HTAC Report to Secretary Bodman

Chairman Lloyd moved the discussion to the latest draft of the letter report to Secretary Bodman. Dr. Byron McCormick recommended adding modifiers to the word "infrastructure," to indicate that infrastructure is more than just fueling—it is also the manufacturing and supply base infrastructure. The Committee agreed to add these terms parenthetically after the word infrastructure on page one of the report. He went on to note that the majority of the suppliers his company deals with are international.

Chairman Lloyd stressed the need to convey that any energy transition, not just fossil fuel to hydrogen, would require extensive national investment. The Committee agreed, and additional language was added. Chairman Lloyd said the report should strongly state that technology validation must continue beyond 2008 since the technology on the road is several years behind the technology in the labs. Dr. McCormick concurred, and the Committee agreed to explicitly communicate the issue of lead time in the letter. The Committee discussed the idea of infrastructure development, noting that "large-scale" infrastructure development is not as big an issue for stationary and portable fuel cells, or even for fuel cell vehicle fleets, as it is for privately-

owned vehicles. They agreed to add language into the report that would convey that this is one reason why these technologies can help to establish early markets.

Dr. Saillant brought up one gap in the Committee's discussion and evaluation of the Posture Plan: not enough attention on the critical need for education and building a technical workforce to handle hydrogen and fuel cell technologies. He stated that this big system change necessitates education and training of technicians, operators, and installers. Mr. John Hofmeister agreed, and described five key "human factor" issues that should be addressed: 1) education and training of government permitting and code officials; 2) establishing a sufficient talent base to supply the necessary technical workforce; 3) conducting education programs at all levels (K-12, trade schools, and universities); 4) developing the knowledge base for the supply chain infrastructure; and 5) providing sufficient, broad-based education to allow for consumer understanding and acceptance. The Committee agreed that it was important to emphasize the need for more attention to education as a whole. The Committee developed and added language to the letter report recommending that the Posture Plan give stronger emphasis to the importance of human factors in making a transition to hydrogen. Dr. Milliken pointed out that the current Posture Plan does provide some discussion of an education activity area, and that she assumed the Committee is looking for an expansion of that discussion. The Committee members agreed that it is an area for improvement in the Posture Plan rather than a gap. Dr. Shaw asked whether people in industry believe there is a skills workforce shortage that needs to be addressed, to which Dr. McCormick answered, "It's massive." Mr. Napoli reminded the Committee that education and dissemination of information was one of the roles the HTAC proposed for the Interagency Task Force.

Discussion returned to comments on draft letter report, and the HTAC recommendation concerning the Posture Plan's well-to-wheel analyses. Dr. Dresselhaus objected to the wording that the results of the well-to-wheels analysis should be "reconciled." She asserted that such reconciliation is not realistic since the models use different assumptions, etc. She suggested that the important goal was to clarify and understand the assumptions, so if there are differences in the results one can determine why. The members agreed and edited this recommendation to accommodate her suggestion. Dr. Dresselhaus also expressed confusion over the use of the term "carbon analyses," and asked what that meant. It was explained that this term was meant to refer to stationary power systems, since "well-to-wheels" analysis did not fit that application. Dr. McCormick pointed out that the term carbon analysis does not quite capture the Committee's intent, however, since the well-to-wheels analyses consider more than just carbon emissions (e.g., criteria pollutants, etc.) He suggested that carbon analysis might be too constraining a term, and that perhaps the Committee's recommendation should be for "similar analysis" (to well-to-wheels) for stationary systems. The group agreed to replace the term "carbon analysis" with "similar analysis," and to enclose well-to-wheels in quotes, to address this issue.

Dr. Dresselhaus expressed concern that the recommendation for downselection could inhibit scientific advances and new discoveries if these decisions are made using economic criteria. She worried that projects could be eliminated or ignored if they do not seem to be cost-effective, even if further research could lead to breakthroughs that would solve the problems. Mr. Wooten disagreed, saying that research programs with limited resources must make decisions about what programs to fund, and decision-making should be done on an economic basis. He went on to say that he agreed with the sentiment to keep some of the novel approaches alive, but argued that the program cannot "fund everything forever; we have to downselect." Dr. McCormick countered by arguing that high-risk research should be performed by the government, and it should not be the government that downselects to the technologies that make business sense. He worried that as industry begins to take some of the current hydrogen and fuel cell designs into production,

government may not put enough emphasis on continuing with higher-risk research on novel approaches. He stressed that high risk research should stay in the government's R&D portfolio. Dr. Dresselhaus noted that some of the research activities she is referring to are more appropriately funded by the National Science Foundation than by DOE, and she will bring this up in discussions with the Interagency Task Force. The Committee agreed that the recommendation in the letter report was satisfactory as written, because it suggested that pathways requiring major breakthroughs should be directed back to exploratory research and also suggested that go/no-go decisions "be consistent with *techno-economic* progress."

After completing the revisions to the letter report to the Secretary, the discussion shifted to how to include the Committee members who were not present for the July 31-August 1 meeting in the review of the final draft report, as revised at the meeting. Dr. Shaw proposed that the Chair and Vice Chair contact those members, provide them with the final draft, and instruct them that this report will go forward to the Secretary unless they convey to the Chair or Vice Chair any *major problems* with the report. Ms. Epping said that it is desirable to get consensus from everyone, so she recommended the Committee give absent members the opportunity to provide input beyond addressing "major problems." Dr. Shaw stressed that the absent members did not have the benefit of participating in the active dialogue about different ideas and the dynamic that facilitated consensus. Vice Chairman Walker concurred, and worried that the process of getting major edits back from those not present, which then have to be sent out to the full Committee and agreed upon, could become overly cumbersome. He expressed his opinion that those members who were not present for the Committee's discussion during the meeting would need to accept what the group who was at the meeting decided, unless they find a major error. It was agreed by the Committee that the Chair and Vice Chair would send out via email the final draft report to the full HTAC for a final review, asking only for comments that address major errors or problems. Comments would be provided back to the Chair and Vice Chair (within a week), who would then incorporate these, as they believe appropriate, into the final report for the Secretary. Dr. Lloyd proposed that he and Vice Chairman Walker would hand-deliver the final letter to the Secretary, which he hoped would be completed by late August or early September. He asked Dr. Milliken to assist them in getting an appointment with the Secretary for this meeting.

Mr. Katsaros asked whether the Committee was still planning to make a presentation on the report to members of Congress and their staff. Chairman Lloyd agreed that this was probably a good idea and suggested that the Committee discuss it further later in the meeting.

15. National Petroleum Council Report Summary

Mr. Hofmeister made a presentation on the draft National Petroleum Council (NPC) report *Facing the Hard Truths about Energy* (http://www.fossil.energy.gov/programs/oilgas/advisorycommittees/Facing_Hard_Truths-Report.pdf). He stated that the Executive Summary does a very thorough job of capturing the highlights of the 430-page draft report. He explained that the group who assembled this report, while called the National *Petroleum Council* (NPC), was composed of three hundred members of the oil and gas industry and six hundred other parties. The report was not meant as an advocacy document for the petroleum industry but rather to look at different energy sources per the assignment from Secretary Bodman. The study found that future demand in the United States for transportation fuels will not be met by domestic sources. He related that the enormous price volatility seen in gasoline had been driven by the inability of American refining to keep pace with domestic demand. He explained that many oil companies are reluctant to build more refinery capacity because so much of the crude oil is/will be imported--why not just import the finished product? Mr. Hofmeister proclaimed that this limitation on domestic manufacturing capacity, as well as the dependence on imported crude oil,

could be a big incentive for hydrogen as an alternative fuel. He described another factor that he believes will increase the possibility of a transition to hydrogen: projections for a significant increase in consumption of coal, primarily for power production, but also in the areas of coal-to-liquids and coal-to-gas. He noted that since utilities cannot afford investments for “clean coal,” more traditional pulverized coal combustion plants are expected to be built, adding carbon dioxide to the environment and therefore increasing the demand for alternative, lower-carbon fuels like hydrogen. He summed up by saying that these three conclusions of the NPC report (limitations in gasoline refining capacity, increasing numbers of pulverized coal plants, and the consequent release of carbon dioxide emissions) may have the most relevance to HTAC and provide the biggest driver for hydrogen as an alternative fuel.

Mr. Hofmeister was concerned that hydrogen was “taking a second seat to biofuels” in terms of how hydrogen or biofuel enters into the country’s infrastructure. He noted that there was little interest by the study participants in hydrogen, as illustrated by the fact that there are only two paragraphs on hydrogen in the entire NPC report. Mr. Hofmeister said that the report’s scenarios do not show any movement at all towards hydrogen before 2015, at which point it could either increase significantly or continue near zero. As another illustration of how hard it is to make transitions in the transportation sector, Mr. Hofmeister explained that the report also does not address the potential opportunity of “dieselizing” U.S. transport fuels as a primary objective, as has been done in Europe. He noted that 50% of the European auto fleet is diesel vehicles. He explained that even with the clear advantages of converting to diesel (diesel engines are more fuel efficient, have an excellent track record of performance, and diesel is a better use of crude oil), the same automobile companies that sell diesel cars in Europe do not attempt to sell them in the U.S. market.

Dr. Shaw asked whether the NPC report included any discussion of plug-in hybrid vehicles as an alternative vehicle option in the short term. Mr. Hofmeister replied that there was mention of it as an option, but that the report was focused on energy supply and demand rather than energy conversion choices and options. Mr. Bawden asked Mr. Hofmeister for his opinion on what would trigger change—what event and what would be the timing? Mr. Hofmeister replied that he believed change would be triggered by one of two things. First would be price, with no idea of what that price point would have to be for the change to occur. Second would be political leadership. Mr. van Dokkum suggested that the European transition to diesel was created by political leadership. Mr. Hofmeister agreed, noting that European political leaders evaluated the scarcity of resources, made the decision to pursue diesel as a primary objective, and then led a public private partnership of a multi-sector industry, using all the tools of government (including tax incentives to lower the cost of diesel fuel and educating consumers about the advantages of diesel engines). Chairman Lloyd added that government’s concern about carbon emissions was also a key driver for the transition.

Mr. Hofmeister spoke about the NPC report’s emphasis on “above ground” issues with respect to the choices and decisions that will be made for fuels, noting that this applies as much to biofuels as it does to conventional oil from the Middle East. He referred to some of the challenges of meeting motor transportation fuel needs with biofuels due to issues such infrastructure, manufacturing, land use, water distribution, various agricultural problems, and consumer acceptance. He answered a question about corn-based ethanol from Vice Chairman Walker by saying that the NPC report assumed the use of second-generation ethanol production from biomass. Vice Chairman Walker replied that he assumed that meant cellulosic ethanol, which would put ethanol availability on the same timeline as hydrogen (in the 2015 time range). Mr. Hofmeister concurred, but noted that “the NPC study did not want to interfere with the current legislative process by opining the reality of the legislation or the President’s ambitions.” He

explained that the President set a goal for reducing motor fuel usage by 20% by 2017, and while no one on the NPC study could imagine that amount of cellulosic ethanol being available by then, it was left to the future to see what happened.

Chairman Lloyd asked whether Mr. Hofmeister was more or less enthusiastic about hydrogen after reading the NPC report. Mr. Hofmeister replied that the NPC study concludes that fossil fuels with advanced environmental technologies will continue to be important for a long period of time. However, he does not personally believe that carbon capture and sequestration technology will be proven in the near term, and that it will likely be expensive and risky. He noted that early pilots have resulted in carbon capture and sequestration costs that are way beyond the early estimates. These doubts, and his previous mention of limited domestic oil refining capability, would give hydrogen an opportunity for growth. He pointed out that the study, in and of itself, does not provide any motivation for companies to invest large sums in hydrogen, adding that it points to a path forward that is “more of a status quo, unless the government leads the pathway forward.”

Mr. Hofmeister continued, noting that the NPC study stressed the near-term need to expand and diversify the national energy supply. To sustain economic growth, affordable energy will be required, but without diversification and expansion, demand will outpace supply and prices will rise. He noted that higher prices for energy build risk into the economy and creates social injustice for the poor. Mr. Hofmeister said that even with this situation, the U.S. House of Representatives handily defeated a recent bill to increase outer continental shelf oil exploration, eliminating any near term opportunity to expand domestic production from this source. Chairman Lloyd asked how long, given authorization, it would take for outer shelf oil drilling to be productive. Mr. Hofmeister replied that it generally takes three to five years to develop a robust flow of new supply. Mr. Bawden asked whether that increase in production would meet demand, to which Mr. Hofmeister answered that it would barely meet demand at that point. Getting ahead of demand, he noted, would require additional domestic production.

Mr. Bawden asked whether Mr. Hofmeister believes that renewable energy will start to play a bigger role in the future. Mr. Hofmeister replied that the NPC report describes the availability of a wide range of renewable energy resources in great detail. The report concludes that they will not grow fast enough over the study period (through 2030) to offset continued requirements for more fossil fuel expansion. Asked whether technology breakthroughs could change this assessment, Mr. Hofmeister replied that the NPC analysis suggested that no one in the study could imagine a cost-reduction breakthrough significant enough to make solar energy anything other than a subsidized energy source by 2020. Wind energy, while cash-positive, was still variable and must be supplemented with alternative systems. In the near term, the study calls for increased conventional fossil energy, and in the longer term calls for accelerating energy from biomass, enabling the long-term viability of coal through carbon capture and sequestration, and expanding nuclear capacity. He explained that the study recognizes that expanding nuclear energy will require increasing the skilled construction workforce, rebuilding the permitting capability, rebuilding the uranium mining capability, and resolving the waste disposal issue. In response to a question about the long term availability of uranium for global nuclear energy demand, Mr. Keuter replied that there is plenty of uranium (in the U.S., Canada and Australia, among other countries) and that the price of uranium currently contributes only about \$1.00 of the total cost of \$50/MWh for nuclear energy. He noted that if the price of uranium were to rise due to increasing demand, the uranium mining industry would quickly respond by reopening closed mines and increasing production.

Mr. Hofmeister also called attention to one of the study's key sections, called "reinforce capabilities to meet new challenges." He explained that this section deals with the problem of the aging infrastructure for refineries, petroleum storage, and pipeline infrastructure, noting that it has been a long time since the industry has done a lot of infrastructure investment. The study also calls out the lagging engineering and science capability in the U.S. and the need for more research and development to improve the efficiency of existing energy conversion devices (such as jet engines and internal combustion engines). He noted that the study also includes section on carbon constraints and potential policies for managing carbon in the future.

Dr. Shaw observed a disconnect between the need to deal with climate change in a carbon-constrained world and the NPC study's emphasis on meeting increased demand using traditional carbon-based fuels. Mr. Hofmeister replied that the NPC study only evaluated realistic possibilities between now and 2030. Dr. Shaw asked whether the NPC considered the ideas of scientists like Jim Hansen, who say that the world does not have until 2030 to begin making big changes in carbon emissions. Mr. Hofmeister responded that the NPC did not consider any "cataclysmic or urgent issues," other than geopolitical concerns, that would drastically affect energy supply or demand.

16. Public Comment Period

Ms. Kathi Epping informed the Committee that no one had signed up in advance to offer public comments during the meeting. Chairman Lloyd asked the general audience whether anyone was present who wanted to make any public comments to Committee. Hearing none, the Committee moved on to its next discussion topic.

17. Statements from Assistant Secretary Karsner

Dr. Lloyd introduced Assistant Secretary for Energy Efficiency and Renewable Energy (EERE) Andy Karsner, noting that he understood there was some confusion over schedules which prevented Mr. Karsner from being able to attend the HTAC meeting on July 31 and ITF meeting on August 1. Assistant Secretary Karsner began by thanking the Committee members for contributing their time to the HTAC, stressing that participation by people of their prominence is very important. He had planned to join the HTAC meeting on July 31, but was called away to present testimony before Congress.

He informed the Committee that on May 31, 2007, the President had announced what he would call a "pivotal" redirection in U.S. climate change policy and approach, noting that much of the responsibility for executing and implementing the President's technology-intensive plan will fall on DOE. He stated that interagency discussions on climate change are moving from "is this a problem?" to "how do we address it and how much will it cost?" Assistant Secretary Karsner conveyed that the hydrogen program is the most mature EERE program in terms of having a comprehensive programmatic approach. He reported that part of his testimony to Congress yesterday concerned a recent U.S. Government Accountability Office (GAO) audit that cited a lack of a comprehensive biofuels strategy, which the program is now trying to address. He also noted that the Secretary has called on the EERE program to take a much more proactive and assertive role in providing federal leadership on energy efficiency technology and policy, and in improving its interaction and coordination with state governments in this area. He stated that as we move to a national transportation plan that accounts for tailpipe emissions and security

concerns with a big picture view, a lot of that effort will be borne out of the maturity of the Hydrogen Posture Plan and the good work that began in the Hydrogen Program in 2003.

Mr. Karsner apologized for not being able to attend the Interagency Task Force meeting on August 1, but that he is certain his Deputy will do an able job. He wanted to make the Committee aware of three upcoming climate change-related meetings. First, the President will convene a meeting of the major emitting nations in the fall of 2007 to quantify emissions goals for a post 2012 timeline. Second, the United Nations Climate Change Conference will be held in Bali, Indonesia on December 3-7, 2007. And third, he reported that there will be a renewable energy conference planned for the first week in March 2008. The Assistant Secretary encouraged the hydrogen community to take advantage of these opportunities to showcase available, successful technologies, describe what is possible, and to “quantify the promise” by showing what the emissions reductions are.

Assistant Secretary Karsner asked for questions and comments. Mr. van Dokkum remarked that it would be helpful for the administration to speak out about the Hydrogen Posture Plan, since it is a very well prepared document, and the suggestions by the HTAC will make it even better. He explained that active support of the administration for these technologies would help retain private capital and venture capital investments in U.S.-based technology development. He asserted that without the leadership of government, the risks of investment are too high. Mr. Karsner asked Mr. van Dokkum what he viewed as the role of hydrogen that should be further amplified. Mr. van Dokkum replied that the automotive industry is clearly the most difficult application for hydrogen and fuel cells; easier applications include stationary power and vehicle fleets, and more effort should be focused on bringing these nearer term technologies into the marketplace. Assistant Secretary Karsner agreed with this assessment.

Vice Chairman Walker relayed the Committee’s concern from the previous day regarding the Assistant Secretary’s intended absence from the inaugural Interagency Task Force meeting. The Committee had made a strong recommendation that the ITF be composed of members at the Assistant Secretary level or higher to assure policy making power. He worried that the Assistant Secretary’s substitution at the first meeting would set a precedent of lower-level designees. Assistant Secretary Karsner appreciated the Committee’s concern and pointed out that it is not unusual for some substitutions to occur at most meetings, especially those that are comprised of high-level decision makers. He stressed that in his case it was his “duties of state” that prevented him from attending the ITF meeting and that this does not reflect a precedent. He stated that his concern in these types of meetings, however, is about substance and not who holds the gavel. He indicated that he intends to chair the second ITF meeting and will work towards making sure that his counterparts at the other agencies are also at the meeting.

Looking at the list of ITF members, Assistant Secretary Karsner asked why there were so many DOE representatives, noting that this seemed unusual. Dr. Milliken answered that there was a representative from each of the four offices within DOE that are involved with hydrogen, adding that there are also four representatives from the Department of Defense, because of the breadth of their activities in hydrogen and fuel cells. Mr. Karsner responded that DOE would need to assess this.

Dr. Lloyd conveyed to Assistant Secretary Karsner his observations from a recent trip to Europe, where there is a strong focus on hydrogen and fuel cells as a storage medium for renewable energy. He said that he was happy to hear about the increased focus on climate change. He noted that the U.S. is in a great position to exert leadership, but unless there is strong forward movement, we will lose the race. Assistant Secretary Karsner agreed that the DOE’s Office of

Energy Efficiency and Renewable Energy should be at center of discussion and international dialogue about climate change, and he is working hard to represent these technologies in those discussions. He communicated that part of his effort will be to communicate “the art of the possible,” or what is needed to provide the connectivity between the technology curves and the necessary capital for the desired outcomes.

Assistant Secretary Karsner told the Committee about the Department’s effort to move fuel cells into the Federal Emergency Management Program, adding that he thought it would be great to get a fuel cell device atop DOE’s Washington headquarters building, complete with viewing platform, before the end of the administration. He expressed his desire for solar panels, fuel cells, etc., on rooftops on many government buildings. He emphasized the need for “nuts and bolts” ideas that “move the needle in a measurable way,” given only eighteen months before a new administration takes over, and he asked for ideas from the Committee members.

Dr. Shaw commented that in the last two to three years, the flow of private capital to small hydrogen and fuel cell development companies has been drying up, and he believes this reduction is partly due to lack of support from the government. Assistant Secretary Karsner remarked that he does not give the government that much credit for moving markets and venture capital. Dr. Shaw countered by noting the Europeans have made significant impacts on the solar energy market through programs they have instituted, such as the feed-in tariff programs for solar energy. He encouraged Assistant Secretary Karsner to support substantial and durable incentive programs that the private sector can rely on to make sound investments. Mr. Hofmeister added that educating Congress and the agencies within the ITF was also a great thing to do because of the importance of building an enthusiastic constituency base; he noted lagging interest in hydrogen within his company when compared to biofuels. Assistant Secretary Karsner agreed that hydrogen is on a timeline beyond biofuels because biofuels is occurring now. He explained that his emphasis is on the present and what we can do now to bring hydrogen and fuel cells forward into today’s energy mix. He noted that one of his highest priorities is to bring fuel cells into the Federal Energy Management Program for procurement. He asked to be told if this initiative is premature or too risky. He asked the Committee to let him know about any early achievements that DOE should be communicating. He said that in his opinion the private sector, if stimulated and supported, will do at least as much to advance new technologies as the federal program. Mr. Chalk advised that discussing the federal government as early adopters was an agenda item for the Interagency Task Force meeting. Chairman Lloyd thanked Assistant Secretary Karsner for his attendance. Assistant Secretary Karsner again thanked the Committee for their time and service, and noted that the Committee’s reports have impact.

18. Wrap up, Other Business, and Next Steps

Chairman Lloyd reviewed his presentation on “Recommendations to the Hydrogen and Fuel Cells Interagency Task Force” (ITF), which he planned to give at the first ITF meeting later that day. Comments from Committee members were incorporated into the presentation.

Chairman Lloyd appointed a subcommittee (consisting of Vice Chairman Walker, Mr. van Dokkum, and Dr. Saillant) to pursue logistics for the HTAC meeting with members of Congress. Asked about the timing of this effort, Mr. Walker explained that since the Congress will likely be busy with appropriations work when they return from recess in September, he would try to target the end of September or early October for the meeting with the House and Senate hydrogen caucuses. He suggested creating handouts for the meeting that could be widely distributed to

staff. Mr. van Dokkum proposed that the intent of the meeting would be to include a high-level report on the HTAC's findings and recommendations.

Mr. Wooten expressed concern that, as a Federal Advisory Committee, HTAC serves to advise Energy Secretary Bodman. He was not sure how that charge fits in with what could be construed as a lobbying activity. He asked for clarification from DOE on the rules governing the group. Vice Chairman Walker stressed that the meeting would be conducted as an informational exercise, not a lobbying activity. He noted that the Committee was created by the Secretary as a result of congressional legislation (EPACT 2005), so efforts to inform the Congress about their progress should not be in conflict with the Committee's mandate in law. Mr. van Dokkum agreed that it would be useful to have some clarification on any restrictions Committee members may have in interacting with members of Congress, so that they do not inadvertently violate any rules. Dr. Milliken committed to talk with the DOE General Counsel for detailed clarification. She noted that this might be a particular concern for any HTAC members who are designated as "Special Government Employees," since government employees are not permitted to lobby Congress. Dr. Lloyd asked if she could try to get an answer from General Counsel in time for a late September meeting. It was agreed that DOE would pursue providing the HTAC members with a written document (by the end of August) that provides guidelines on what is acceptable and what is not.

Dr. Saillant asked whether the Committee was setting a deadline by which it wanted the Secretary to respond to the letter report. Dr. Milliken reported that EPACT calls for the Secretary to submit his report to Congress on the HTAC recommendations with the FY2009 budget submission, in February 2008. Dr. Shaw asked whether it would be possible or desirable for the HTAC to ask Secretary Bodman for a response to their report prior to February 2008. Dr. Milliken said that the Committee could ask for a response by an earlier date, especially if the Committee submitted its report within the next month. Dr. Shaw proposed that the Committee submit the letter report and then ask for a meeting with the Secretary to discuss it after he has had some time to read it and consider his response. The Chair and Vice Chair agreed to this strategy and asked for Dr. Milliken's assistance in setting this meeting up with the Secretary.

Chairman Lloyd asked that the old list of HTAC action items be presented to the group for consideration. Given time constraints, Dr. Shaw suggested that the list be sent to the Committee via email so everyone could 1) review and rank the activities by priority, 2) delete any items that do not need to be pursued or have already been completed, and 3) add any items that you would like the Committee to pursue. Chairman Lloyd agreed and asked DOE to follow up and ask for responses from Committee members within three weeks.

After some discussion on scheduling the next HTAC meeting, Chairman Walker set the desired timeframe for the next HTAC meeting as mid to late November or early December. Ms. Epping stated that she will work with members concerning their availability to find a suitable date.

Mr. Keuter volunteered to make a short presentation on nuclear production of hydrogen and to address the Committee's questions about nuclear power. He would also like to see a presentation on production of hydrogen from coal. Chairman Lloyd suggested that both be added to the next HTAC meeting agenda. Mr. Keuter also suggested scheduling a presentation by someone from EPRI on their recent study about scenarios and carbon emissions from the power sector.

Mr. Katsaros expressed his desire for the Committee to get a better understanding of what is going on in developing and deploying hydrogen and fuel cells outside the United States, particularly government policies that are facilitating technology. He said he has a contact at

Honda who could make a presentation. Other suggestions for possible presenters on international hydrogen and fuel cell activities included Toyota and the European Union. In addition, Mr. van Dokkum also suggested the Japanese Automobile Research Institute (JARI) as a potential presenter. Dr. McCormick volunteered a GM employee who sits on an oversight committee for Japan.

Mr. John Mizroch (DOE Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy) remarked that the International Partnership for a Hydrogen Economy (IPHE), which includes membership of 16 countries plus the E.U., is a good vehicle for better understanding and engaging in international hydrogen initiatives. He noted that the IPHE Steering Committee meets twice yearly, and the Implementation Liaison Committee meets twice yearly at different times. He believes the IPHE ought to be publishing and sharing information about what different countries are doing to pursue the hydrogen economy. He suggested DOE could help the HTAC become more knowledgeable about IPHE and its activities. Chairman Lloyd agreed with this suggestion and noted that he has not had much success in the past in learning about what IPHE was doing. Dr. Milliken noted that the next IPHE Steering Committee meeting would be in Rome in November 2007, and the next Implementation-Liaison Committee meeting would be in February 2008 in Germany.

Dr. Shaw requested that the Committee develop a work plan for completing the detailed Committee comments on the Posture Plan, including the assignments for the different subcommittees.

Chairman Lloyd thanked everyone for attending, and the HTAC meeting was adjourned at 12:24 p.m. EDT.