

HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE

MEETING MINUTES

February 17 – 18, 2011

Radisson Hotel, 2020 Jefferson Davis Highway, Arlington, VA

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Day 1 - February 17, 2011

1. U.S. Department of Energy program presentations

1.1. Steve Chalk, Chief Operating Officer of Energy Efficiency and Renewable Energy (EERE) and Deputy Assistant Secretary of Renewable Energy, U.S. Department of Energy (DOE)

Mr. Chalk spoke about EERE priorities for fiscal year (FY) 2012. Given the fiscal restraints of the current climate, DOE leadership has proposed a budget that focuses on what is seen as near-term, large-impact technologies, for example solar and wind energies and industrial efficiency. Mr. Chalk asked that the Hydrogen and Fuel Cells Technical Advisory Committee (HTAC) help the DOE determine its strategy for moving forward with the Hydrogen and Fuel Cells Technology Program (FCTP).

1.2. Sunita Satyapal, Program Manager, EERE Fuel Cell Technologies Program, U.S. Department of Energy

Dr. Satyapal presented an overview of the FCTP and current activities within the context of the EERE's four pillars for success: high impact innovation, speed and scale, fostering talent, and capturing hearts and minds. She then went on to discuss leveraging opportunities for collaboration across programs given the upcoming budget constraints. Dr. Satyapal shared a brief update on recent R&D analysis and provided feedback on HTAC-DOE collaboration and future needs.

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

Questions, answers, and discussion

- Dr. Lloyd asked Dr. Satyapal to discuss the FCTP's collaboration with other Federal agencies such as the Environmental Protection Agency (EPA).
 - Dr. Satyapal mentioned the Interagency Working Group and responded that the FCTP has done some work with other federal and state agencies, including the EPA, the California Air Resources Board (CARB), the U.S. Department of Defense, and the U.S. Department of Transportation/National Highway Traffic Safety Administration (DOT/ NHTSA), among others, and outlined future opportunities for collaboration.
- Chairman Shaw asked if any programs will be forced to abruptly cease operations as a result of the budget cuts.
 - Dr. Satyapal responded that large starts were not initiated because of budget uncertainty in the last couple of years. The three Hydrogen Storage Centers of Excellence will terminate as planned. Any project that cannot be fully funded will most likely be deferred rather than terminated.
- Chairman Shaw asked when the program would notify its contractors of project deferment.
 - Dr. Satyapal stated that no final decisions will be made until the FY11 and FY12 budgets are finalized.

- Dr. Carlin and Dr. Satyapal discussed messaging opportunities and how to best ensure the delivery of information, including progress and needs.

2. Adoption of minutes from previous HTAC meeting.

The minutes of the October 14-15, 2010 HTAC meeting were adopted without comment.

3. Five Pillars of a Hydrogen Economy, Jeremy Rifkin, Founder and President of the Foundation on Economic Trends

Mr. Rifkin began by discussing two “game changing” events in recent history that have set the context for why we need to move to a hydrogen economy in the 21st century: oil reaching \$147 per bbl in June of 2008 and the failure of the Copenhagen climate talks. According to Mr. Rifkin, now is the time to implement a five pillar industrial revolution based on distributed energy technology. The pillars are: 1) committing to a 20% renewable energy by 2020; 2) distributed energy systems that rely on buildings to generate their own power; 3) efficient and effective energy storage; 4) an accessible, smart grid; and 5) hydrogen-based and other alternative transportation systems.

Mr. Rifkin concluded by saying that we are at “a dangerous moment in history”, and that we must move quickly to renewables and hydrogen.

Questions, answers, and discussion

- Mr. Eggert asked Mr. Rifkin to comment on the government policies and regulation that would be required for such investment.
 - Mr. Rifkin responded that there are several levels of support, for example federal feed-in tariffs. Financial leveraging has worked successfully on the local level as well, with cities like Rome investing a portion of their gross domestic product.
 - Mr. Koyama asked Mr. Rifkin to share his opinion on why the European Union (EU) is so much further ahead of the United States in implementing a clean energy economy.
 - Mr. Rifkin responded that Europeans have had to contend with fewer resources, such as available land, for a long time. Furthermore, energy is frequently described within the framework of economic prosperity, and regardless of political party, people accept that an “energy revolution” would create millions of jobs.

4. Small and medium enterprise presentations

4.1. Per Balslev, Dantherm Power A/S

Dr. Balslev presented the work of Dantherm Power A/S, a manufacturer of backup power systems and fuel-cell-based micro combined heat and power (micro-CHP) systems. The topics covered in the presentation included Dantherm’s backup power modules, including production, integrated solutions, and product development since 2003; Tetra, a digital radio communication system that allows emergency personnel to communicate in a closed, encrypted network; and a Danish demonstration of a fuel-cell-based micro-CHP system that is fueled by natural gas based on low-temperature polymer electrolyte membrane (PEM) and solid oxide fuel cell (SOFC) technology.

Dr. Balslev also discussed a proposal for a U.S.-Danish research, development, and demonstration program to advance fuel cells and the fuel cell market.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_02_2011_balslev_dantherm.pdf

4.2. Mike Upp, ClearEdge Power

Mr. Upp presented on the ClearEdge5 micro-CHP system, a new 5-kilowatt (kW) commercially available stationary PEM fuel cell system that converts natural gas into electricity and heat. Mr. Upp gave a summary of the benefits of the ClearEdge system, which offers a leveled cost of electricity as low as 9 cents per kilowatt-hour (kWh), a 37% reduction in carbon dioxide (CO₂) emissions and 40% reduction in fuel compared to grid-supplied power, near-zero emissions of nitrogen oxides and sulfur oxides, easy scalability, and fuel flexibility. ClearEdge envisions its products as integral components of a Smart Grid powered by distributed systems, with potential customer base includes data, light commercial facilities, residential units, and utilities.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_02_2011_clearedge_upp.pdf

4.3. Robert Stokes, Versa Power Systems, Inc.

Mr. Stokes gave an overview of Versa Power Systems' SOFC technology for stationary and mobile applications, including market opportunities, applications, and commercialization considerations. He also shared the technology advantages of their SOFC system, including high electrical generation efficiency, reduced emissions of CO₂ and nitrogen and sulfur oxides, siting and fuel flexibility, and cogeneration potential. The company's 2010/2011 efforts are focused on stack module development and system integration (10 to 50kW); 2012/2013 efforts will focus on 250 kW power module and system integration.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_02_2011_versa_power.pdf

4.4. Hiroshi Takami, JX/ENEOS

Mr. Takami presented on JX Nippon Oil & Energy Corporation's residential fuel cell applications. At this point JX/ENEOS has conducted a large-scale residential fuel cell demonstration project, the Fukuoka Hydrogen Town, with more than 1,500 systems installed between 2005 and 2008. The key technical challenges that must be overcome before JX can meet its 2020 sales goal include improving reliability (reducing the failure rate from <10% per year to <1% per year), reducing the unit price (from \$30,000 per unit to <\$5,000 per unit), and improving performance (increasing unit life from 40,000 hours to >10 years).

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_02_2011_jx_eneos_takami.pdf

Questions posed to Mr. Balslev, Mr. Upp, Mr. Stokes, and Mr. Takami

- Chairman Shaw asked each presenter to comment on his most significant technological challenge.
 - Mr. Balslev, Mr. Upp, Mr. Stokes, and Mr. Takami all agreed that their biggest problems are not technological, but the challenge of overcoming high prices and low volume. Mr. Takami added that his company is also focused on overcoming reliability issues.
- Mr. van Dokkum stated that he does not feel the industry has done enough to ensure durability of components. He asked the speakers for advice on overcoming this issue.
 - Mr. Stokes stated that his company is focusing on engineering investments to hit reliability targets. Mr. Upp added that fuel processor issues in particular need to be overcome.
- Mr. Novachek asked whether or not the systems presented are capable of dealing with cycling.
 - Mr. Stokes responded that they do not currently but by the third quarter of this year they should have two systems capable of dealing with load cycling. He added that they do not consider cycling issues a challenge.
- Dr. Satyapal asked the presenters their opinions on the DOE focusing less on funding early technology R&D and more on balance of plant and systems integration.
 - Mr. Stokes agreed that this would be helpful.
 - Mr. Upp added that getting the technology in the hands of the consumer is as challenging as developing the technology.
 - Mr. van Dokkum brought up the tax incentive designed to tackle this issue.
 - Mr. Upp responded that while the incentive does help, for most people it is not enough.
- Mr. Koyama asked Mr. Stokes if there is an industry standard for the number of thermal cycles an SOFC system should be able to perform.
 - Mr. Stokes responded that most systems are handling hundreds of cycles, but that the importance of cycling is overstated.

5. Discussion: HTAC Annual Report

Mr. Eggert initiated a discussion of the 2010 HTAC Annual Report by stating that the main goal at this time is to shorten the document to 8 pages. Each member had previously received a copy of the draft report and was invited to share his or her feedback.

Questions, answers, and discussion

- Mr. Walker began by suggesting that an executive summary be added to the report.
 - Mr. Eggert, Mr. Rose, Mr. van Dokkum, Mr. Walker, and Mr. Cardillo offered to work together to write a 1-page executive summary for the report.
- Dr. Satyapal suggested that given the Secretary's press conference on this issue, domestic competitiveness should be highlighted. Several members agreed.
- Dr. Ogden suggested more of an emphasis be made on the technical accomplishments.
- Mr. van Dokkum suggested the report be renamed to take the focus away from commercialization.

- Others suggested focusing more on “activities.”
 - It was agreed upon that the name would be changed to “Hydrogen and Fuel Cell Commercialization and Technical Development Activity.”
- Mr. Eggert stated that he and his team would further edit the document to reduce the length to 8 pages.

Day 2 – February 18, 2011

6. Public comment period

6.1. Ruth Cox, President and Executive Director, Fuel Cell and Hydrogen Energy Association (FCHEA)

Ms. Cox gave a brief overview of the work she and her team at FCHEA have been doing to raise the profile of hydrogen and fuel cells. In meeting with Congress and stakeholders, she stressed that hydrogen and fuel cells are being commercially deployed and demonstrating competitive advantage *today*; they are not just technologies of the future. She stated that she also speaks frequently about the fuel cell deployments that the U.S. military is undertaking and planning.

Questions, answers, and discussion

- Mr. Cardillo asked if Ms. Cox and the FCHEA have been emphasizing international competitiveness when they lobby congress.
 - Ms. Cox responded that they have been stressing the investment that other countries, for example South Korea, have made in fuel cells and the fact that American fuel cell companies are finding bigger markets for their products outside of the U.S.
- Mr. Eggert asked if the FCHEA has inventoried hydrogen and fuel cell activities by congressional district.
 - The FCHEA has used this approach, including tallying earmarks and jobs created by DOE funding of hydrogen and fuel cell technologies.

7. GM Hawaii project update, Jeff Kissel, President and CEO, The Gas Company (TGC)

Mr. Kissel presented an overview of Hawaii’s effort to implement a statewide renewable hydrogen and methane infrastructure. Hydrogen and fuel cells will help Hawaii to reach its goal of 40% renewable energy generation by 2030 by tapping into TGC’s existing synthetic natural gas line to deliver a planned 7,000 kilograms of hydrogen per day, which would support up to 15,000 vehicles on Oahu. Existing hydrogen and natural gas production can increase by approximately 40% without significant plant modification. Furthermore, collaboration with General Motors will accelerate deployment.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_02_2011_hftc_kissel.pdf

Questions, answers, and discussion

- Chairman Shaw asked Mr. Kissel to share what he considers a worst case scenario.

- Mr. Kissel does not want drivers to feel any difference between a fuel cell vehicle and a conventional vehicle in the way that they drive, are fueled, or are serviced. If they do feel differences, that would not be a good outcome.
- Mr. Cardillo asked if there was any concern over running out of hydrogen in the pipeline, considering the concentration is only 20%.
 - Mr. Kissel stated that this was not a concern.
- Dr. Taylor asked whether or not they have experienced embrittlement problems in the steel pipelines.
 - Mr. Kissel responded that they have been testing the pipeline regularly in the three years they have been running hydrogen but have yet to see any degradation in the steel.
- Mr. Rose asked Mr. Kissel's opinion on changing the selling unit of hydrogen from kilogram to pound in order to avoid "sticker shock" from the consumer.
 - Mr. Kissel responded that he has been considering such marketing techniques.
- Mr. Eggert asked Mr. Kissel to comment on the policy framework in place to help Hawaii achieve its ambitious clean energy goals.
 - Mr. Kissel serves on a committee that is trying to implement a renewable energy plan driven by a portfolio approach, taking advantage of each island's natural resources.
 - Mr. Kaya, who also serves on the committee, added that the renewable energy targets are all embodied in state statutes and require the compliance of the utility companies. There is also an efficiency standard in addition to the renewables standard.
- Mr. van Dokkum asked how TGC is dealing with issues of hydrogen purity in the pipelines, given that different stakeholders have different purity requirements.
 - Mr. Kissel stated that if need be, they are prepared to dispense pure hydrogen from the plant source and truck it to dispensing locations.
- Mr. Lloyd asked the pressure of the gas in the pipelines.
 - The gas is pressurized to 350 pounds per square inch (psi) in the transmission lines at 10 psi at the distribution mains.
- Chairman Shaw pointed out that TGC is dependent on petroleum to produce its hydrogen and asked if there were any future plans to find other sources of hydrogen.
 - Mr. Kissel responded that neither he nor the state can foresee becoming completely independent from petroleum, but TGC does expect to get 50% of their hydrogen from renewable sources by 2015 if the planned transmission lines come online.

8. Working group updates

8.1. Hydrogen Enabling Renewables Working Group, Frank Novachek, Chair

Mr. Novachek updated the committee on the recent work undertaken by the working group, formed to examine the ways that hydrogen and fuel cells can help enable high penetrations of variable renewable power. Ultimately the group plans to summarize the opportunities and challenges it identifies in a white paper to DOE management. Recent work included brainstorming potential applications for hydrogen use. The group identified four general areas: 1) energy storage; 2) energy transmissions and distribution; 3) improved renewable resource utilization via vehicle fuel production; and 4) supplement to natural gas. Mr. Novachek then lead a discussion, presenting information needs and asking for input from the committee.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_02_2011_novachek.pdf

Questions, answers, and discussion

- Mr. Novachek asked the HTAC if they agree with the working group's decision to initially focus on grid energy storage.
 - Mr. van Dokkum responded that he believes it to be the right decision, especially given the high rate of return by investing in power flow control.
 - Mr. Shaw suggested examining the benefit of using renewables with hydrogen generation as distributed energy "reservoirs."
 - Mr. Eggert added that the California Energy Commission recently commissioned a study to evaluate various energy storage technologies deployed at utility and distributed scales. Mr. Eggert will send a link to the proceedings page and study docket.
- Mr. Cardillo asked how the round trip efficiency of hydrogen compares to other storage technologies.
 - Mr. Novachek replied that it is generally lower than that of other storage technologies, but that the value of energy storage systems depends on the price per kilowatt hour of the system. Efficiency, capital costs, replacement costs, and disposal issues all contribute to the cost.
- Mr. van Dokkum offered to share the link for a hydrogen storage study recently commissioned in Italy.
- Mr. Novachek stated that the group would include storage of electricity produced from biomass and stranded wind in its analysis.
- Mr. Kaya stated that there is an urgent need for grid storage now because renewables are already reaching 50% penetration in Hawaii.
- Mr. Eggert asked Dr. Satyapal for input on how best to structure grid storage analysis to leverage support from DOE.
 - Dr. Satyapal stated that there are several opportunities to coordinate on studies with the wind and solar programs, as well as the Office of Electricity and ARPA-E.

8.2. Stimulating the Hydrogen Infrastructure, Dr. Kathy Taylor, Chair

Dr. Taylor's working group, created to assemble information on worldwide hydrogen infrastructure development, will have a report ready by April 15th that identifies opportunities for the DOE. She shared information on the group's recent work, including examining some of the work coming out of Europe.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_02_2011_taylor_infrastructure.pdf

Questions, answers, and discussion

- Chairman Shaw recommended that Dr. Taylor look into the analysis that Linde recently performed on setting refueling station price points. They concluded it would cost \$500,000 to build a 50 kilogram per day (kg/day) station and that the investment could

not be recouped on any reasonable price/kg of dispensed hydrogen. However, a 2,400 kg/day station would cost \$2 million and would result in a return on investment even if less than its full output of hydrogen were sold daily.

- Dr. Ogden stated that these findings concur with studies she has seen. Small stations do not make money.
- Mr. Eggert added that there are innovative designs that allow for a lower level of investment to be made for smaller stations that can later be expanded into bigger stations, thereby minimizing forecourt costs.
- Dr. Satyapal reiterated what Mr. Chalk had previously stated, that it is important to start investing in low volume stations if we can get the capital costs down.
- Chairman Shaw stated that as long as the depreciation of short term capital costs overwhelms the long term revenue stream, one cannot expect to make a profit on a small fueling station.
- Mr. Freese added that early stations should be scalable and some don't have to be anything more than a mobile refueler.

9. DOD R&D and Deployment Update, Richard Carlin, Head, Sea Warfare & Weapons Department, Office of Naval Research, Department of the Navy

Mr. Carlin presented on the Department of Defense's (DOD) role in fuel cell technology, primarily as an early adopter and principal demonstrator. Fuel cells have become an integral part of the DOD's energy strategy for winning and preventing wars, reflected in the DOD-DOE memorandum of understanding (MOU) that identifies a framework for cooperation and partnership between the two agencies. Mr. Carlin went on to share some examples of the military's use of fuel cells, including soldier and stationary power.

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

Questions, answers, and discussion

- Dr. Satyapal suggested that they look into how to continue some of the projects that had been cost shared between DOD and DOE given that several of the program's FY12 budgets could potentially be moving to zero.

10. McKinsey Report overview -- "A Portfolio of power-trains for Europe: a fact-based analysis; The role of Battery Electric Vehicles, Plug-in Hybrids and Fuel Cell Electric Vehicles"

10.1. Dennis Hayter, Vice President, Business Development, Intelligent Energy, Ltd.

Mr. Hayter explained that the impetus for commissioning the McKinsey report was based on bringing together the multilayer regional and national clean energy mobility programs and companies forming in the EU and moving forward with cohesive analysis. More than thirty private stakeholders were involved and over 10,000 proprietary data points were analyzed. Mr. Hayter gave an overview of the process and various scenarios considered and discussed several of the report outcomes, including that fuel cell vehicles are the lowest-carbon solution for longer trips and family-sized cars.

>>see full presentation at http://www.hydrogen.energy.gov/pdfs/htac_02_2011_hayter.pdf

10.2. Dr. Sandy Thomas, ex-President, H2Gen Innovations, Inc.

Dr. Thomas reviewed the technical results of the McKinsey report, including that an 80% reduction in greenhouse gas (GHG) emissions into the atmosphere will require a 95% reduction in road transport GHG emissions. Specific technical information on batteries and fuel cells was explained, and Dr. Thomas argued that fuel cell vehicles are ready for commercialization now. The presenter also compared the total cost of ownership for various drive trains now and in the future.

>>see full presentation at

http://www.hydrogen.energy.gov/pdfs/htac_02_2011_mckinsey_thomas.pdf

Questions posed to both Mr. Hayter and Dr. Thomas

- Chairman Shaw asked Dr. Satyapal if she knows whether or not Secretary Chu is aware of the McKinsey Report.
 - Dr. Satyapal responded that while she does not personally know if the Secretary has read the report, representatives from his office have been present at several meetings that covered the report in depth.
- Mr. Cardillo asked Mr. Hayter to comment on why biofuels were left out of the report.
 - Mr. Hayter responded that biofuels were not included as part of the fueling mix because of their low impact potential in Europe due to the limitations of production and issues of availability in Europe.
- Mr. Rose suggested that Mr. Hayter and Dr. Thomas present to the Energy Efficiency and Renewable Energy Advisory Committee (ERAC). He went on to ask Mr. Hayter to comment on the report's policy impact in Europe.
 - Mr. Hayter responded that the report had significant impact in Europe, specifically resulting in the continuation of the EU's Fuel Cells and Hydrogen Joint Technology Initiative for another five years. It also had impact on Germany's H2 Mobility Initiative; and the United Kingdom's Automotive Working Council is now including hydrogen in its long term goals.
- Mr. Rose asked Mr. Hayter to comment on the independence of the report as rumors to the contrary were circulating.
 - Mr. Hayter responded that although hydrogen stakeholders were involved in the report, in his opinion it is fair and unbiased.
 - Mr. Freese agreed.
- Mr. Koyama asked why the DOE's hydrogen vehicle storage targets are so high, especially compared to the current storage technology for electric vehicle batteries.
 - Dr. Thomas responded that they are looking into this issue now. The targets had recently been revised (lowered) by DOE.

11. Adjourn

Chairman Shaw adjourned the meeting at 2:17 pm

**FOURTEENTH MEETING OF THE
HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE
PARTICIPANT LIST
February 17-18, 2011**

HTAC Members Present

- Peter Bond
- Mark Cardillo
- Richard Carlin
- Anthony Eggert
- Charles Freese
- John Hofmeister
- Maurice Kaya
- Harol Koyama
- Alan Lloyd
- Frank Novachek
- Joan Ogden
- Geraldine Richmond
- Bob Rose
- Bob Shaw
- Kathleen Taylor
- Jan van Dokkum
- Robert Walker
- Bill Wylam

HTAC Members Not Present

- Levi Thompson

U.S. Department of Energy Staff

Office of Energy Efficiency and Renewable Energy

- Steve Chalk
- Alan Chen
- Peter Devlin
- Kathi Epping Martin
- Monterey Gardiner
- Fred Joseck
- Michael Mills
- Sunita Satyapal

Members of the Public in Attendance

- Per Balslev – Dantherm Power A/S
- Dave Bruderly – Citizen
- John Christenson – National Renewable Energy Laboratory
- Ruth Cox – Fuel Cell & Hydrogen Energy Association
- Nicholas Easley – The Foundation on Economic Trends
- Keith Eastin – Louis Berger Group
- Thomas Gross – Independent Consultant

- Dennis Hayter – Intelligent Energy, Ltd.
- Peter Hoffmann – Hydrogen & Fuel Cell Letter
- Praveen Kedar – General Motors
- Jeff Kissel – The Gas Company
- Kristen Nawoj – SRA
- Kathleen O’Malley – SRA
- Kevin Ott – Los Alamos National Laboratory
- Jeremy Rifkin – The Foundation on Economic Trends
- Mark Ruth – National Renewable Energy Laboratory
- Robert Stokes – Versa Power Systems, Inc.
- Brian Sullivan – IBM
- George Sverdrup – National Renewable Energy Laboratory
- John Tak – Canadian Hydrogen and Fuel Cell Association
- Hiroshi Takami – JX / ENEOS
- Sandy Thomas – Consultant
- Mike Upp – ClearEdge Power
- David Van Horn – Louis Berger Group

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